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Factory and industrial management

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INDEX TO VOLUME XXVI

October, 1903, to March, 1904.

LEADING ARTICLES.

Abbot, Gen. Henry L. The Solution of the Isthmian-Canal Problem 481
Alcohol Motor—Mechanical and Commercial Aspects of the (Illustrated) *Henri Dupays* 682
Allen, Chas. V. Diamond Mining in the Kimberley Field (Illustrated) 81, 177
Aluminothermics—Mechanical and Metallurgic Applications of (Illustrated) *Emile Guarini* 561
Apartment Houses—The Power Plant and Mechanical Equipment of *Percival Robert Moses* 713
Apprenticeship System—An Example of the Modern Development of the *L. D. Burlingame* 511
Apprentices in an Engineering Works—The Training of (Illustrated) *C. E. Downton* 380
Apprentice. *See also* Mechanic.
Ball, W. Valentine The Penalty Clause in Engineering Contracts 674
Baxter, George H. Hydraulic Power Appliances in the Engineering Industries (Illustrated) 878
Bell, Louis The Relation of Electric Inventions to Human Activity (Illustrated) 967
Boilers and Fireboxes—Special Features in the Design of Locomotive (Illustrated) *Chas. S. Lake* 62, 216, 390
Bolton, Reginald P. Mechanical Auxiliaries to the Economy of the Fireroom (Illustrated) 950
Boundary District of British Columbia—Ore Quarrying in the (Illustrated) *E. Jacobs* 236
British Columbia—Ore Quarrying in the Boundary District of (Illustrated) *E. Jacobs* 236
British Columbia—The Water Powers of (Illustrated) *E. Jacobs* 333

British Railways—Locomotives for Special Service on (Illustrated) *J. F. Gairns* 700
Burlingame, L. D. An Example of the Modern Development of the Apprenticeship System 511
Canal Organization and Personnel in the Building of the Panama *Fullerton L. Waldo* 488
Canal Problem—The Solution of the Isthmian *Gen. Henry L. Abbot* 481
Canal—The Republic of Columbia and the Panama (Illustrated) *John Geo. Leigh* 1
Capital, Costs, Profits and Dividends—Manufacturing: (Illustrated) *Henry Hess* 367
Capital—The Issues Between Labor and *Egbert P. Watson* . 75
China—Railway Making in (Illustrated) *Thomas H. Reid* . 321
Coal-Mining Industry of the United Kingdom (Illustrated) *R. A. S. Redmayne* 20, 193, 400
Collins, G. Fred Mining and Railway Development in Peru (Illustrated) 641
Colombia and the Panama Canal—The Republic of (Illustrated) *John Geo. Leigh* 1
Combustion Motor—Lines of Progress in the Efficiency of the (Illustrated) *Edward C. Warren* 664
Contracts—The Penalty Clause in Engineering *W. Valentine Ball* 674
Costs, Profits and Dividends—Manufacturing: Capital (Illustrated) *Henry Hess* 367
Cutting Speeds and Feeds with the New Tool Steels *Oberlin Smith* 569
Deep Mining—The Limits and Possibilities of (Illustrated) *E. H. Roberton* 546
Development of Power-Driven Machinery in the Mine (Illustrated) *E. H. Roberton* 925
Developments of the Steam Turbine—Recent (Illustrated) *A. Rateau*. 49
Diamond Mines—The Mechanical Equipment of the Kimberley (Illustrated) *Chas. V. Allen* 177
Diamond Mining in the Kimberley Field (Illustrated) *Chas. V. Allen* 81
Diemer, Hugo The Fixing of Piece-Work Rates (Illustrated) . 169
Dividends—Manufacturing: Capital, Costs, Profits and (Illustrated) *Henry Hess* 367
Downton, C. E. The Training of Apprentices in an Engineering Works (Illustrated) 380
Duncan, Louis Technical Education—What It Should Be . 161

Dupays, Henri MECHANICAL AND COMMERCIAL ASPECTS OF THE ALCOHOL MOTOR (Illustrated) 682

EDUCATION, WHAT IT SHOULD BE—TECHNICAL *Louis Duncan. With Editorial Commentary* 161

ELECTRIC INVENTIONS TO HUMAN ACTIVITY—THE RELATION OF (Illustrated) *Louis Bell* 967

ELECTRIC-RAILWAY TRIALS—THE MARIENFELDE-ZOSSEN HIGH-SPEED (Illustrated) *Alfred Gradenwitz* 494

ELECTRIC TROLLEY VEHICLES WITHOUT RAILS (Illustrated) *Emile Guarini* 33

ENGINEERING SOCIETIES—THE HOMES OF THE GREAT (Illustrated) *Henry Harrison Suplee* 520

ETHICS OF WORKSHOP MANAGEMENT *Egbert P. Watson* . . 250

EXAMPLE OF THE MODERN DEVELOPMENT OF THE APPRENTICESHIP SYSTEM *L. D. Burlingame* 511

FEEDS WITH THE NEW TOOL STEELS—CUTTING SPEEDS AND *Oberlin Smith* 569

FIREBOXES—SPECIAL FEATURES IN THE DESIGN OF LOCOMOTIVE BOILERS AND (Illustrated) *Chas. S. Lake* 62, 216, 390

FIREROOM—MECHANICAL AUXILIARIES TO THE ECONOMY OF THE (Illustrated) *Reginald P. Bolton* 950

FIXING OF PIECE-WORK RATES (Illustrated) *Hugo Diemer* . . 169

Flynt, H. Spencer SOME SOURCES OF ERROR IN WATER TREATMENT 231

FOUNDRY OPERATIONS—LABOR-SAVING MACHINERY IN (Illustrated) *Richard Moldenke* 896

Gairns, J. F. LOCOMOTIVES FOR SPECIAL SERVICE ON BRITISH RAILWAYS (Illustrated) 700

GAS ENGINE. *See* COMBUSTION MOTOR

GAS—RECENT DEVELOPMENTS IN THE PRODUCTION OF WATER (Illustrated) *A. Humboldt Sexton* 205

Gradenwitz, Alfred THE MARIENFELDE-ZOSSEN HIGH-SPEED ELECTRIC RAILWAY TRIALS (Illustrated) 494

GREECE—THE FIRST HYDRO-ELECTRIC STATION OF (Illustrated) *Emile Guarini* 694

Guarini, Emile ELECTRIC TROLLEY VEHICLES WITHOUT RAILS (Illustrated) 33

Guarini, Emile MECHANICAL AND METALLURGIC APPLICATIONS OF ALUMINOTHERMICS (Illustrated) 561

Guarini, Emile THE FIRST HYDRO-ELECTRIC STATION OF GREECE (Illustrated) 694

Hess, Henry MANUFACTURING: CAPITAL, COSTS, PROFITS AND DIVIDENDS (Illustrated) 367

HIGH-SPEED ELECTRIC-RAILWAY TRIALS—THE MARIENFELDE-ZOSSEN (Illustrated) *Alfred Gradenwitz* 494

HOMES OF THE GREAT ENGINEERING SOCIETIES (Illustrated) *Henry Harrison Suplee* 520

Hunt, Robert W. THE WORLD'S GREAT LABOR SAVERS AND LABOR SERVERS (Illustrated) 803

HYDRAULIC POWER APPLIANCES IN THE ENGINEERING INDUSTRIES (Illustrated) *George H. Baxter* 878

HYDRO-ELECTRIC STATION OF GREECE—THE FIRST (Illustrated) *Emile Guarini* 694

INVENTORS. *See* LABOR SAVERS.

ISOLATED PLANTS—THE SYSTEMATIZED OPERATION OF (Illustrated) *Percival Robert Moses* 410

ISSUES BETWEEN LABOR AND CAPITAL *Egbert P. Watson* . . 75

ISTHMIAN-CANAL PROBLEM—THE SOLUTION OF THE *Gen. Henry L. Abbot* 481

ISTHMIAN CANAL. *See also* PANAMA CANAL.

Jacobs, E. ORE QUARRYING IN THE BOUNDARY DISTRICT OF BRITISH COLUMBIA (Illustrated) 236

Jacobs, E. THE WATER POWERS OF BRITISH COLUMBIA (Illustrated) 333

KIMBERLEY DIAMOND MINES—THE MECHANICAL EQUIPMENT OF THE (Illustrated) *Chas. V. Allen* 177

KIMBERLEY FIELD—DIAMOND MINING IN THE (Illustrated) *Chas. V. Allen* 81

LABOR AND CAPITAL—THE ISSUES BETWEEN *Egbert P. Watson* . 75

LABOR SAVERS AND LABOR SERVERS—THE WORLD'S GREAT (Illustrated) *Robert W. Hunt* 803

LABOR-SAVING MACHINERY IN FOUNDRY OPERATIONS (Illustrated) *Richard Moldenke* 896

LABOR'S RISE THROUGH LABOR-SAVING MACHINERY *F. H. Rose* . . 836

Lake, Chas. S. SPECIAL FEATURES IN THE DESIGN OF LOCOMOTIVE BOILERS AND FIREBOXES (Illustrated) 62, 216, 390

Leigh, John Geo. THE REPUBLIC OF COLOMBIA AND THE PANAMA CANAL (Illustrated) 1

Letheule, Paul THE METROPOLITAN RAILWAY OF PARIS (Illustrated) 349

LIMITS AND POSSIBILITIES OF DEEP MINING (Illustrated) *E. H. Roberton* 546

LINES OF PROGRESS IN THE EFFICIENCY OF THE COMBUSTION MOTOR (Illustrated) *Edward C. Warren* 664

LOCOMOTIVE BOILERS AND FIREBOXES—SPECIAL FEATURES IN THE DESIGN OF (Illustrated) *Chas. S. Lake* 62, 216, 390

LOCOMOTIVES FOR SPECIAL SERVICE ON BRITISH RAILWAYS (Illustrated) *J. F. Gairns* 700

MACHINERY IN THE MINE—THE DEVELOPMENT OF POWER-DRIVEN (Illustrated) *E. H. Roberton* 925

MANUFACTURING: CAPITAL, COSTS, PROFITS AND DIVIDENDS (Illustrated) *Henry Hess* 367

MARIENFELDE-ZOSSEN HIGH-SPEED ELECTRIC-RAILWAY TRIALS (Illustrated) *Alfred Gradenwitz* 494

MECHANICAL AND COMMERCIAL ASPECTS OF THE ALCOHOL MOTOR (Illustrated) *Henri Dupays* 682

MECHANICAL AND METALLURGICAL APPLICATIONS OF ALUMINOTHERMICS (Illustrated) *Emile Guarini* 561

MECHANICAL AUXILIARIES TO THE ECONOMY OF THE FIREROOM (Illustrated) *Reginald P. Bolton* 950

MECHANICAL EQUIPMENT OF APARTMENT HOUSES—THE POWER PLANT AND *Percival Robert Moses* 713

MECHANICAL EQUIPMENT OF THE KIMBERLEY DIAMOND MINES (Illustrated) *Chas. V. Allen* 177

MECHANIC OF THE FUTURE AND HIS TRAINING *Egbert P. Watson* . 726

METALLURGIC APPLICATIONS OF ALUMINOTHERMICS—MECHANICAL AND (Illustrated) *Emile Guarini* 561

METROPOLITAN RAILWAY OF PARIS (Illustrated) *Paul Letheule* . . 349

MINE—THE DEVELOPMENT OF POWER MACHINERY IN THE (Illustrated) *E. H. Roberton* 925

MINING AND RAILWAY DEVELOPMENT IN PERU (Illustrated) *G. Fred Collins* 641

MINING—THE LIMITS AND POSSIBILITIES OF DEEP (Illustrated) *E. H. Roberton* 546

MODERN DEVELOPMENT OF THE APPRENTICESHIP SYSTEM—AN EXAMPLE OF THE *L. D. Burlingame* 511

Moldenke, Richard LABOR-SAVING MACHINERY IN FOUNDRY OPERATIONS (Illustrated) 896

Moses, Percival Robert THE POWER PLANT AND MECHANICAL EQUIPMENT OF APARTMENT HOUSES 713

Moses, Percival Robert THE SYSTEMATIZED OPERATION OF ISOLATED PLANTS (Illustrated) 410

MOTOR—LINES OF PROGRESS IN THE EFFICIENCY OF THE COMBUSTION (Illustrated) *Edward C. Warren* 664

ORE QUARRYING IN THE BOUNDARY DISTRICT OF BRITISH COLUMBIA (Illustrated) *E. Jacobs* 236

ORGANIZATION AND PERSONNEL IN THE BUILDING OF THE PANAMA CANAL *Fullerton L. Waldo* 488

PANAMA CANAL—ORGANIZATION AND PERSONNEL IN THE BUILDING OF THE *Fullerton L. Waldo* 488

PANAMA CANAL—THE REPUBLIC OF COLOMBIA AND THE (Illustrated) *John Geo. Leigh* 1

PANAMA CANAL. *See also* ISTHMIAN CANAL.

PARIS—THE METROPOLITAN RAILWAY OF (Illustrated) *Paul Letheule* 349

PENALTY CLAUSE IN ENGINEERING CONTRACTS *W. Valentine Ball* . 674

Personnel in the Building of the Panama Canal—Organization and *Fullerton L. Waldo* 488
Peru—Mining and Railway Development in (Illustrated) *G. Fred Collins* 641
Piece-Work Rates—The Fixing of (Illustrated) *Hugo Diemer* 169
Power Plant and Mechanical Equipment of Apartment Houses *Percival Robert Moses* 713
Prime Mover and Its Influence on the World's Progress (Illustrated) *John E. Sweet* 846
Profits and Dividends—Manufacturing: Capital, Costs (Illustrated) *Henry Hess* 367
Quarrying in the Boundary District of British Columbia—Ore (Illustrated) *E. Jacobs* 236
Railway Development in Peru—Mining and (Illustrated) *G. Fred Collins* 641
Railway of Paris—The Metropolitan (Illustrated) *Paul Letheule* 349
Railway Making in China (Illustrated) *Thomas H. Reid* 321
Railways—Locomotives for Special Service on British (Illustrated) *J. F. Gairns* 700
Railway Worker—What the Inventor Has Done for the *Arthur M. Waitt* 872
Rateau, A. Recent Developments of the Steam Turbine (Illustrated) 49
Recent Developments in the Production of Water Gas (Illustrated) *A. Humboldt Sexton* 205
Recent Developments of the Steam Turbine (Illustrated) *A. Rateau* 49
Redmayne, R. A. S. The Coal-Mining Industry of the United Kingdom (Illustrated) 20, 193, 400
Reid, Thomas H. Railway Making in China (Illustrated) 321
Relation of Electric Inventions to Human Activity (Illustrated) *Louis Bell* 967
Republic of Colombia and the Panama Canal (Illustrated) *John Geo. Leigh* 1
Rise of Labor Through Labor-Saving Machinery *F. H. Rose* 836
Roberton, E. H. The Development of Power-Driven Machinery in the Mine (Illustrated) 925
Roberton, E. H. The Limits and Possibilities of Deep Mining (Illustrated) 546
Rose, F. H. The Rise of Labor Through Labor-Saving Machinery 836
Sexton, A. Humboldt. Recent Developments in the Production of Water Gas (Illustrated) 205
Smith, Oberlin. Cutting Speeds and Feeds with the New Tool Steels 569

SOLUTION OF THE ISTHMIAN-CANAL PROBLEM *Gen. Henry L. Abbot* 481
SOME SOURCES OF ERROR IN WATER TREATMENT *H. Spencer Flynt* 231
SPECIAL FEATURES IN THE DESIGN OF LOCOMOTIVE BOILERS AND FIRE-BOXES (Illustrated) *Chas. S. Lake* . . . 62, 216, 390
STEAM ENGINE. *See* PRIME MOVER.
STEAM TURBINE—RECENT DEVELOPMENTS OF THE (Illustrated) *A. Rateau* 49
STEELS—CUTTING SPEED AND FEEDS WITH THE NEW TOOL *Oberlin Smith* 569
STOKING. *See* FIREROOM.
Suplee, Henry Harrison. THE HOMES OF THE GREAT ENGINEERING SOCIETIES (Illustrated) 520
Sweet, John E. THE PRIME MOVER AND ITS INFLUENCE ON THE WORLD'S PROGRESS (Illustrated) 846
SYSTEMATIZED OPERATION OF ISOLATED PLANTS (Illustrated) *Percival Robert Moses* 410
TECHNICAL EDUCATION—WHAT IT SHOULD BE *Louis Duncan. With Editorial Commentary* 161
TOOL STEELS—CUTTING SPEEDS AND FEEDS WITH THE NEW *Oberlin Smith* 569
TRAINING OF APPRENTICES IN AN ENGINEERING WORKS (Illustrated) *C. E. Downton* 380
TRAINING—THE MECHANIC OF THE FUTURE AND HIS *Egbert P. Watson* 726
TROLLEY VEHICLES WITHOUT RAILS—ELECTRIC (Illustrated) *Emile Guarini* 33
UNITED KINGDOM—THE COAL-MINING INDUSTRY OF THE (Illustrated) *R. A. S. Redmayne* 20, 193, 400
VEHICLES WITHOUT RAILS—ELECTRIC TROLLEY (Illustrated) *Emile Guarini* 33
Waitt, Arthur M. WHAT THE INVENTOR HAS DONE FOR THE RAILWAY WORKER 872
Waldo, Fullerton L. ORGANIZATION AND PERSONNEL IN THE BUILDING OF THE PANAMA CANAL 488
Warren, Edward C. LINES OF PROGRESS IN THE EFFICIENCY OF THE COMBUSTION MOTOR (Illustrated) 664
WATER GAS—RECENT DEVELOPMENTS IN THE PRODUCTION OF (Illustrated) *A. Humboldt Sexton* 205
WATER POWERS OF BRITISH COLUMBIA (Illustrated) *E. Jacobs* . 333
WATER POWER. *See also* PRIME MOVER.
WATER TREATMENT—SOME SOURCES OF ERROR IN *H. Spencer Flynt* 231
Watson, Egbert P. ETHICS OF WORKSHOP MANAGEMENT . . 250
Watson, Egbert P. THE ISSUES BETWEEN LABOR AND CAPITAL . 75
Watson, Egbert P. THE MECHANIC OF THE FUTURE AND HIS TRAINING 726

[illegible]
[illegible]
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Accumulators (see Storage Battery)
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[illegible]
[illegible]
[illegible]
[illegible]
Electric Lighting—[illegible]
[illegible]
Engineering [illegible]
Engineering [illegible]
Engineering—[illegible]
Engineering [illegible] the United States
Engineering [illegible]
Engineering—[illegible]
Engineering [illegible]
Europe—The Grand [illegible] Railway
Exhaust Steam—The [illegible]
Experiments [illegible] Resistance
[illegible]
[illegible]
[illegible]
High-Speed Steel—[illegible] Tools
High-Speed [illegible]

Ice Breakers, Modern............... 1003
Index—The Engineering.....123, 283, 447, 603, 761, 1005
Industrial Economy, Engineering Index.........138, 295, 459, 615, 774, 1017
Industry—The Influence of Science upon 259
Influence of Engineering Education .. 982
Influence of Science upon Industry.. 259
Instruction of Apprentices.......... 438
Invention—The Nature of 1001
Invention. *See also* Patent.
Iron and Steel Pipe—Wrought 277
Laboratory—A Swiss Mechanical 600
Lighting—Possible Economies in Electric 104
Liquid Fuel—Possibilities of 263
Localization of Engineering Societies 596
Machine-Shop Process—Grinding as a 434
Machine Tools and High-Speed Steel 1002
Manufacturing Plants—Electricity in. 592
Marine and Naval Engineering, Engineering Index.......139, 296, 460, 616, 775, 1019
Marine Engines—Non-Reversible ... 755
Marine Use—Petroleum Motors for . 106
Materials—The Deformation of 590
Mathematics and Engineering 266
Mechanical Engineering, Engineering Index........141, 297, 461, 618, 777, 1020
Mechanical Laboratory—A Swiss..... 600
Mechanical Road Traction 986
Mechanical Road Vehicles 425
Metals—The Elastic Limit of 423
Metric System in Engineering 430
Mineral Resources of the United States 109
Mining and Metallurgy, Engineering Index......148, 304, 469, 625, 787, 1027
Mississippi—The Regulation of the... 426
Modern Coking Processes 432
Modern Ice Breakers 1003
Modern Naval Boilers 752
Modern Transatlantic Steamships ... 101
Money Value of Technical Training . 589
Motors for Marine Use—Petroleum .. 106
Motors for Pumps—Electric 437
Nature of Invention 1001
Naval Boilers—Modern 752
New Suspension Bridge at New York 760
Nickel-Steel Alloys—The Theory of.. 102
Non-Reversible Marine Engines 755
Northernmost Railway of the Earth.. 747
Observation—Strobographic Methods of 750
Oil Engines. *See* Petroleum Motors.
Patent-Law Administration 997
Patent. *See also* Invention.
Petroleum Motors for Marine Use ... 106
Pipe—Wrought Iron and Steel 277
Population—Engineering and 274
Portable Applications of Acetylene.... 116
Possibilities of Liquid Fuel......... 263
Possible Economies in Electric Lighting 104
Power Generation from Heat 428
Power Stations—Economy of Fuel in 111
Practical Advantage of Superheating 757
Preparation of Boiler Feed Water.. 748
Production of Radium 981
Pumps—Electric Motors for 437
Pumps—Flow in Centrifugal 435
Radium—Production of 981
Railroad Work—Gas Engines in 994
Rails in Service — Stremmatograph Tests of 113
Railway Construction in Switzerland 996
Railway Engineering, Engineering Index.........152, 309, 473, 630, 791, 1032
Railway Motor—Single-Phase 988
Railway of Europe—The Grand Central 261
Railway of the Earth—The Northernmost 747
Recent Experiments in Gliding Flight 272
Refining—Electrolytic Copper 279
Regulation of the Mississippi 426
Resistance of Road Vehicles to Traction 268
Road Traction—Mechanical 986
Road Vehicles—Mechanical 425
Road Vehicles to Traction—Resistance of 268
Roofs—Effect of Wind on 445
Science upon Industry—The Influence of 259
Screw Propulsion for Warships 739
Sea Water on Alloys—The Action of 270
Shipbuilding in Great Britain—The Development of 581
Single-Phase Railway Motor 988
Smelting of Copper—The Electrical.. 282
Smoke Prevention 745
Societies—The Localization of Engineering 596
Specific Heat of Steam 985
Steamships—Modern Transatlantic .. 101
Steam—Specific Heat of 985
Steam—The Generation of Superheated 587
Steam—The Utilization of Exhaust.. 443
Steam Traction—Electric and 280
Steel—Heat Treatment of.........275, 991
Steel — Machine-Tools and High-Speed 1002
Steel Pipe—Wrought Iron and 277
Steels—High-Speed Tool............ 599
Storage Battery—Edison 585
Street and Electric Railways, Engineering Index 154, 311, 477, 634, 794, 1034
Stremmatograph Tests of Rails in Service 113
Strobographic Methods of Observation 750
Study of Carbon Vapor............. 597
Suez Canal—The Growth of the 441
Superheated Steam—Generation of... 587
Superheating—Practical Advantages of 757
Suspension Bridge at New York—The New 760
Swiss Mechanical Laboratory 600
Switzerland—Railway Construction in 996

Tangential Water Wheel Efficiencies 121
Technical Education in Germany .. 999
Technical Training—The Money Value of 589
Temperature of Flames 743
Tests of Rails in Service—Strematograph 113
Theory of Nickel-Steel Alloys 102
Tools and High-Speed Steel—Machine 1002
Tool Steels—High-Speed 599
Traction—Electric and Steam 280
Traction—Mechanical Road 986
Traction—Resistance of Road Vehicles to 268
Transatlantic Steamships—Modern.. 101
Treatment of Steel—The Heat 275
Typhoid—Filtration and 754
United States—Engineering Education in the 115
United States—Mineral Resources of the 109
Utilization of Exhaust Steam.... 443
Utilization of Wastes.... 118
Value of Technical Training—The Money 589
Vapor—A Study of Carbon.... 597
Vehicles—Mechanical Road 425
Vehicles to Traction—Resistance of Road 268
Wages—The Determination of 579
Warships—Screw Propulsion for.... 739
Wastes—The Utilization of.... 118
Water—The Preparation of Boiler Feed 748
Water Wheel Efficiencies—Tangential 121
Wind on Roofs—Effect of 445
Workshop Economics 583
Wrought Iron and Steel Pipe 277

TRODUCTION TO AUTHORS, - PAGE 7
DEX TO ADVERTISEMENTS, - " 11
HE BUYERS' DIRECTORY - - " 15

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THE REPUBLIC OF COLOMBIA AND THE PANAMA CANAL—
Industrial and Political Conditions in the Mainland States — **John Geo. Leigh** 1
THE COAL-MINING INDUSTRY OF THE UNITED KINGDOM—
A Review of its Engineering and Economic Development — **R. A. S. Redmayne** 20
ELECTRIC TROLLEY VEHICLES WITHOUT RAILS—
Traction Systems Adapted to Lines of Light Traffic Density — **Emile Guarini** 33
RECENT DEVELOPMENTS OF THE STEAM TURBINE—
The Latest Types—their Applications and their Economy — **A. Rateau** 49
BRITISH PRACTICE IN DESIGNING LOCOMOTIVE BOILERS—
The Struggle for Steaming Efficiency Under Forced Working — **Chas. S. Lake** 62
THE ISSUES BETWEEN LABOR AND CAPITAL—
Faults of Trade Unionism and Mistakes of Employers — **Egbert P. Watson** 75
DIAMOND MINING IN THE KIMBERLEY FIELD—
Modern Methods of Working the Mines and Extracting the Gems — **C. V. Allen** 81

REVIEW OF THE ENGINEERING PRESS.

THE NOTABLE ARTICLES OF THE MONTH—BRITISH, CONTINENTAL, AMERICAN—101-122
FOR FULL TABLE OF CONTENTS SEE PAGE 5.

THE ENGINEERING INDEX.

With Descriptive Notes indicating the Exact Character and Purpose of Current Leading Articles in the Technical Press of Great Britain, the Continent, and the United States.

CIVIL ENGINEERING, - - - - - - 123
ELECTRICAL ENGINEERING, - - - - - 128
GAS WORKS ENGINEERING, - - - - - - 135
INDUSTRIAL ECONOMY, - - - - - 138
MARINE AND NAVAL ENGINEERING, - - - - 139
MECHANICAL ENGINEERING, - - - - - - 141
MINING AND METALLURGY, - - - - - - - 148
RAILWAY ENGINEERING, - - - - - - - 152
STREET AND ELECTRIC RAILWAYS, 154

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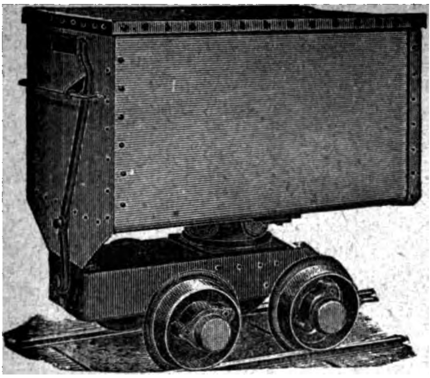

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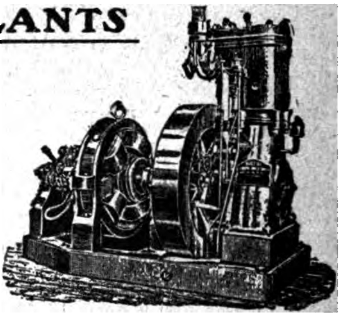

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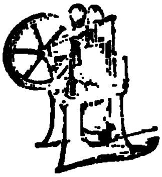

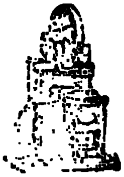

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THE ENGINEERING MAGAZINE
"THE WORLD IS ITS FIELD"

VOL. XXVI. OCTOBER, 1903. No. 1.

THE REPUBLIC OF COLOMBIA AND THE PANAMA CANAL.

By John Geo. Leigh.

As these sheets are printed, the reports from Bogotá are conflicting, but for the greater part unfavourable—some of them apparently maliciously biassed. The immediate trend of the negociations is highly uncertain. But we hold to our faith that the project will ultimately be brought to a triumphantly successful completion, by virtue of its own inherent right to survive through its superior merit. The economic and engineering advantages of the Panama Canal line are so great that it must be acquired for the world's commerce, and the present barriers will fall, as others have fallen, before the insistent progress of the demand for "the best." Mr. Leigh's article is interesting in giving an idea of the country as a whole, outside of the canal zone of which so much has been heard. THE EDITORS.

IT is easy to over-estimate the importance, actual and contingent, of the latest phase of Isthmian Canal negociations. Hasty conclusions, based upon partial and not always reliable information, or influenced by individual prejudices or morbid deference to what promises to be the more popular view, are part of the price we are sometimes asked to pay for the services of a luxuriant, enterprising, and encyclopædic press. George Washington, speaking of periodical publications in the year 1788, is said to have described "such easy vehicles of knowledge" as " more happily calculated than any other to preserve the liberty, stimulate the industry, and meliorate the morals of a free and enlightened people." All this is probably as true at the beginning of the twentieth century as it was at the end of the eighteenth. Nevertheless, it is a quite open question whether the influence of our great newspapers today is not more closely associated with dexterous use of modern resources for the annihilation of time and distance than with whole-hearted desire for the right guidance of popular opinion.

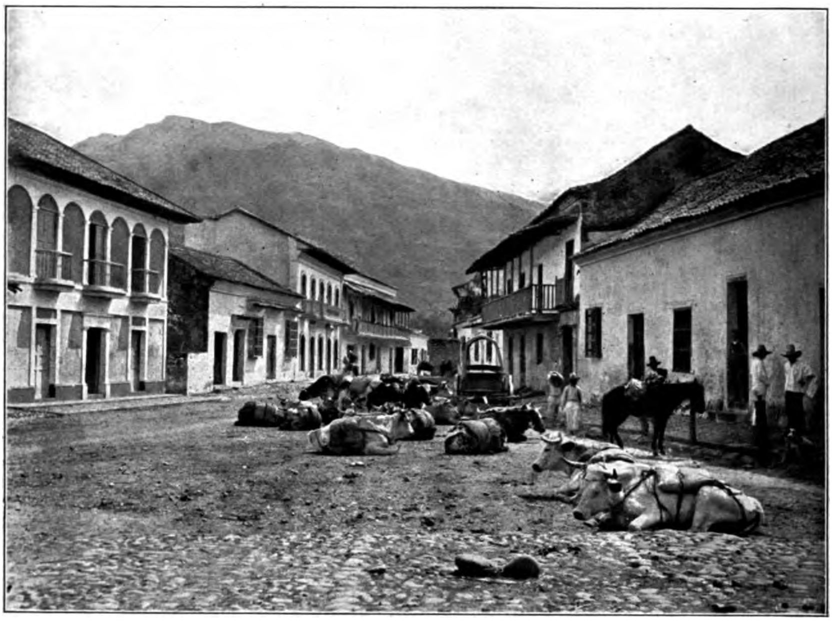
No sooner was it announced that the Colombian Senate had rejected the canal treaty, signed at Washington on January 23rd last by Mr. John Hay and Señor Herran, as official representatives of their respective countries, than the majority of newspapers in England, and some, at least, in the United States, gravely assured their readers that "Now we have heard the last of Panama." This phrase is evidently much-esteemed in the office of a certain London journal, for it loomed large in editorial comments not only upon recent news from Bogotá, but also, early in 1902, in relation to the remarkable vote of the United States House of Representatives in endorsement of Mr. Hepburn's Nicaragua canal bill; and I doubt not that an investigation of the file would be rewarded with frequent disclosures of the same, or equivalent, words applied to other untoward incidents in the history of the Panama undertaking. Pretty much the same kind of story might probably

A SQUARE IN BOGOTÁ.

CARTAGENA—A SEAPORT AND RAILWAY TERMINUS IN THE PROVINCE OF BOLIVAR.

be told of not a few American periodicals, which, "raised" on the idea that the Nicaragua route was practically synonymous with the expression "Isthmian Canal," are still loath to recognise, as a serious factor, the existence of a formidable competitor. It is a shrewd business maxim that if any statement is printed often enough, the public in the end will most certainly believe it. The death and burial of the Panama project have been so frequently enlarged upon that it is small wonder there are many people convinced of their actual occurrence.

It may be quite freely admitted that the rejection of the treaty by the Colombian Senate is an annoying rebuff to the Administration of the United States, and a matter for sincere regret to all well-wishers of the speediest completion of a navigable highway between the Atlantic and Pacific oceans, calculated to be of service to the commerce of the world. But it by no means implies that there is an end of the question, that the only solutions of the difficulty which has been created are either to ignore the Government at Bogotá, or, with the best grace possible, fall back upon the Nicaragua-Costa Rica route. These are counsels of despair, unbecoming a great people not altogether innocent of blame in the matter. The situation is one which calls for dispassionate and careful consideration, and as a first step to this we should frankly ask ourselves whether adequate pains have been taken towards honest study of Colombian sentiment. The latter may be all that it is represented to be—sordid, bombastic and the like; but it is not enough to say so, even though the statement be the reflex of conviction. To all questions there are two sides, and it is worthy of note that even now, after the lapse of many weeks, we cannot be said to know precisely the reasons which actuated the hostile vote.



TYPICAL STREET SCENE IN A COLOMBIAN CITY.

Much has been made of the circumstance that the treaty conflicted with the Constitution of Colombia, inasmuch as it involved the renunciation of certain sovereign rights—of civil jurisdiction, of police, and of criminal jurisdiction over foreigners—in the zone of territory through which the canal is to pass. The Colombian Constitution, we are told, expressly forbids any alienation of territory, and we are asked to believe that the instrument is so sacrosanct in the eyes of Colombians that not even for millions of dollars and other material advantages would Congress or the people permit it to be tampered with. In Spanish America, politicians are lawyers when they are not soldiers; though prone to illegal acts in practice, they never hesitate to invoke, as matter of theory, the strictest letter of the law, and nothing delights them more than opportunity to air their patriotism for the benefit of the foreigner and pompously express the most elevated of sentiments. These amiable characteristics have resulted, in the case of Colombia, in no fewer than seven Constitutions, three changes in the very title of the Republic, and local and general "revolutions" so frequent that even the best informed historians of the country find it difficult to enumerate them in correct chronological order. The best test of the value of Senatorial speeches concerning the sanctity of the Constitution will be found in the fact that the rejection of the Hay-Herran treaty was promptly followed by the introduction of a measure providing for constitutional amendments likely to smooth the way for further negociations.

Another explanation offered by Colombian diplomatists is that the construction of a Panama canal by a foreign government will virtually destroy its international character and its neutrality as a highway open to all nations in times of war as well as peace. They point out that this was one of the main conditions of the concessions granted to the French companies, and unctuously dilate upon Colombia's appreciation of its duties to mankind, as evidenced by its unselfish championship of the

HONDA, ON THE UPPER MAGDALENA RIVER, STATE OF TOLIMA.

A CUSTOM OF THE COUNTRY.

original aim of the canal. Evidently the Colombians have read more carefully or been more impressed by the utterances of certain United States newspapers and politicians before and after the ratification of the second Hay-Pauncefote convention, than by the terms of that instrument or the oft-repeated official declaration that the "fixed policy" of the United States in regard to any isthmian canal is its dedication to "the common use of all nations, on the most liberal terms and a footing of perfect equality for all."

According to a semi-official statement issued for the delectation of English readers, "the Colombian people abhor the idea of the dismemberment of their fatherland." "Swayed by the ideal of the integrity of its territory," the Republic has shown itself "untainted by mercenary motives," and consequently "deserves the sympathy of the whole world." It is, we are told, the transgression of fundamental principles, combined with greediness of gain, which breaks up national union and concord; and all persons tempted to doubt that ardent, self-sacrificing devotion to political ideals is, and has ever been, the common attribute of Colombians are dismissed from further notice as saturated with that "baneful commercialism whose highest aim is the accumulation of wealth." This, presumably, is "pretty Fanny's way" of conveying the information that dread of American "expansion" dictated the rejection of the treaty.

The arguments which figure so prominently in the Colombian statement of the case, and each of which, we are assured, "sufficiently justifies" the action of the Bogotá notables, do not by any means exhaust the list of possible explanations. The opponents of the treaty made considerable play with quotations from speeches delivered in the

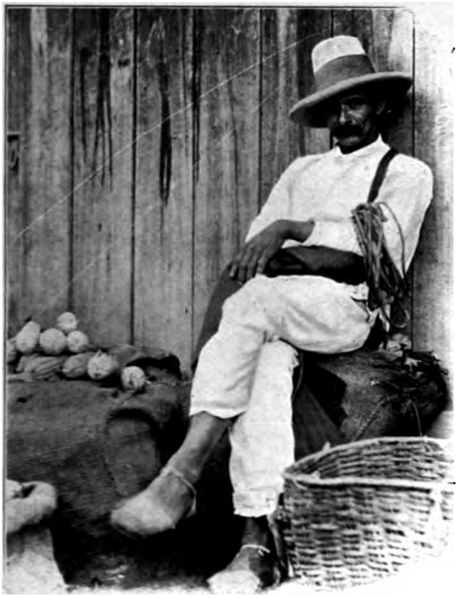
United States Senate during the not always edifying debates which preceded the passing of the Spooner bill and the ratification of the Hay-Herran convention; and it must be confessed that the *Congressional Record* reports many statements and threats eminently calculated to provoke apprehension and deeply wound Colombian susceptibilities. Moreover, it is far from certain that anti-American prejudice was not sensibly strengthened by the use made of these speeches, and other more potent arguments, by citizens of the United States, less recognizant of the national needs than of individual and vested interests. These are upleasant considerations, upon which I am reluctant to dwell, but they require to be borne in mind when—as I hope may be shortly the case—satisfactory means are devised to overcome existing difficulties.

There is one point bearing upon Colombian opposition to the canal, quite irrespective of the terms of the Hay-Herran convention, which, in my opinion, has been too long ignored. To the outside world, other than persons who have lived or travelled in the Republic, the topography of the country has seemed a matter of no significance. In reality, it plays a very important part in the councils of Colombia, and should serve as a forcible illustration of the fact that political boundaries are frequently less important than geographical actualities. Thanks to its unique position in relation to the commerce of the world and the 47 miles of railway which links its two seaboards, the "State" of Panama is far better known to most foreigners than the mainland of the Republic. This is matter for regret, for, as regards climate, natural wealth, and beauty, it cannot be compared with any one of the other eight constituent departments with which it is politically united. It is the spoilt child of the Republic, a cause of constant anxiety and expense, yet invariably humoured and de-

THE COLOMBIAN LOAFER.

ferred to. Every Colombian believes that the isthmus is the most coveted spot in the world, and that, if retained as part of the Republic, it will, some time or other, prove a source of incalculable wealth. The people of the department are fully alive to the advantages which they may claim as the result of this appreciation, and consequently seek to exercise, whenever it may suit their humour, the remarkable powers enjoyed under the Constitution of 1861-85, which denied to the federal government the right to interfere in the affairs of the constituents States, even for the punishment of crime or the preservation of public order—indeed, expressly provided that "when one State of the Union shall be at war with another, or the citizens of any one State shall be at war amongst themselves, the Government of the Union is required to preserve the strictest neutrality." While such conditions prevailed *de jure,* the original canal concessions were granted: and it has ever been a very sore point with the most active spirits holding the reins of government in the isthmus, or aspiring to do so, that so much, or, indeed, any share, of the "boodle" derived from the sale and prolongation of concessions found its way into the treasury at Bogotá. These and other circumstances duly considered, it will be readily understood that the proposed

ON THE LINE OF THE PANAMA RAILWAY.

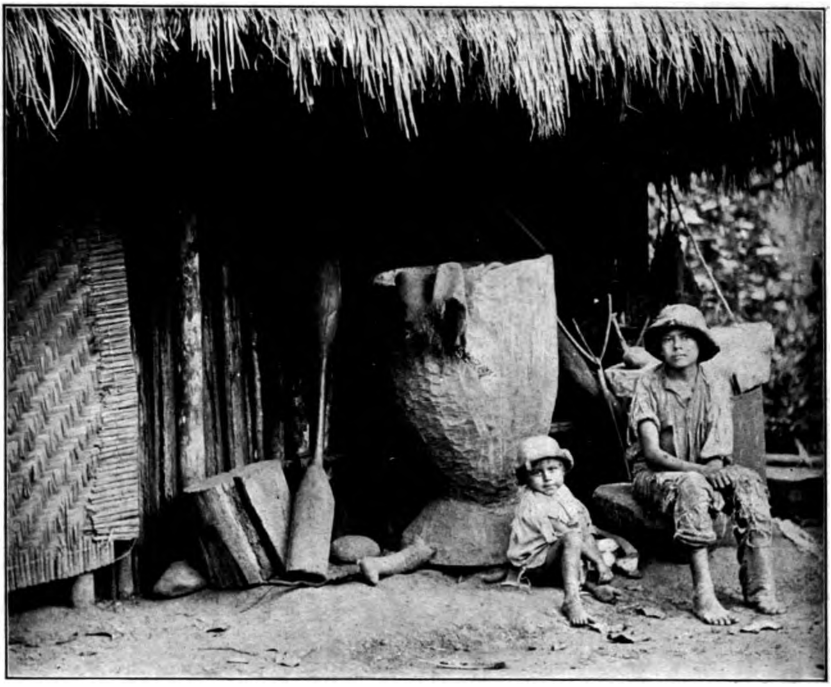


IN THE MARKET.

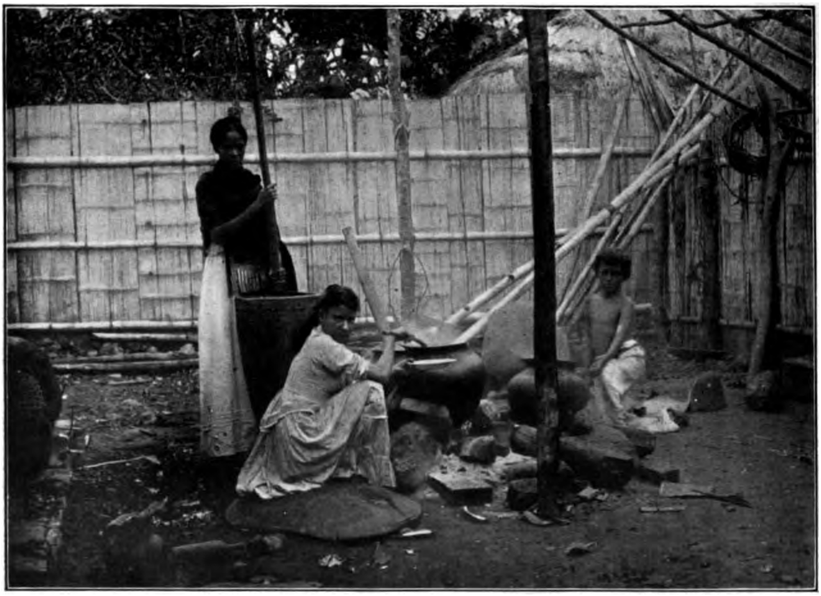
payment by the United States of such a large sum as that offered in the rejected treaty has caused considerable heart-burning throughout the Republic. It is not so much a question of amount, as its division and the *personnel* of the parties likely to be in power when the money is paid, which disturb Colombian equanimity.

The people of the department of Panama are undoubtedly united in desiring the completion of the canal, and, so far as unanimity is possible where financial considerations intervene, they may be said to favour the ratification of the treaty with America. The same is true, with less reservation, of the commercial classes throughout the Republic, who recognise in the canal and the legitimate exercise of American influence certain to follow a solution of present difficulties, guarantees for the development of the country and more orderly and honest government. Unfortunately for Colombia and the world's progress, these

COLOMBIAN GAMINS.

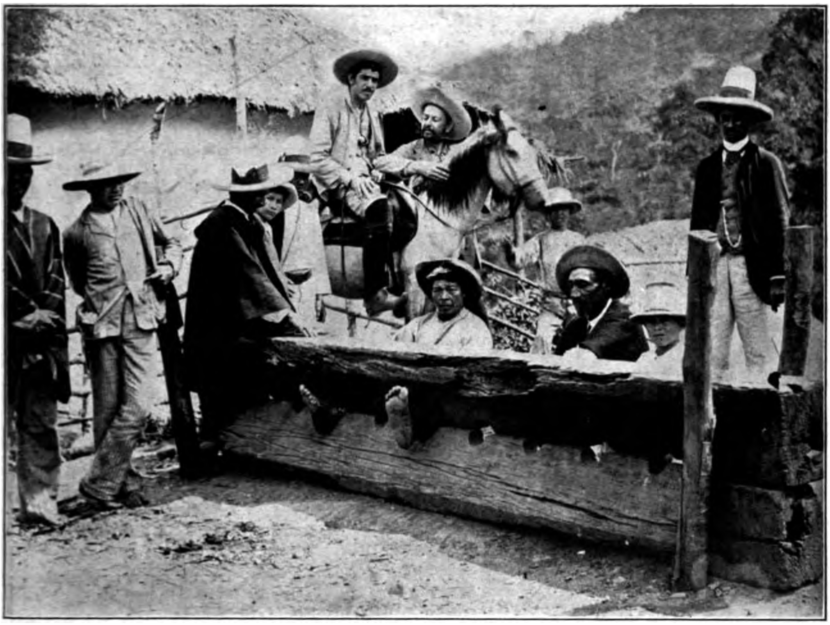


THE PILON—OR NATIVE PESTLE AND MORTAR.

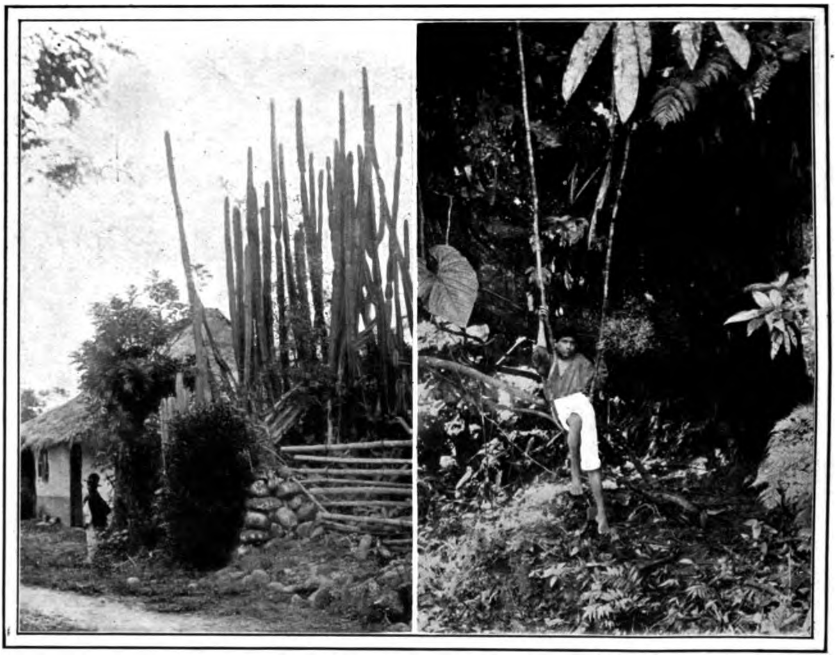


KITCHEN OF A COLOMBIAN HOUSE.

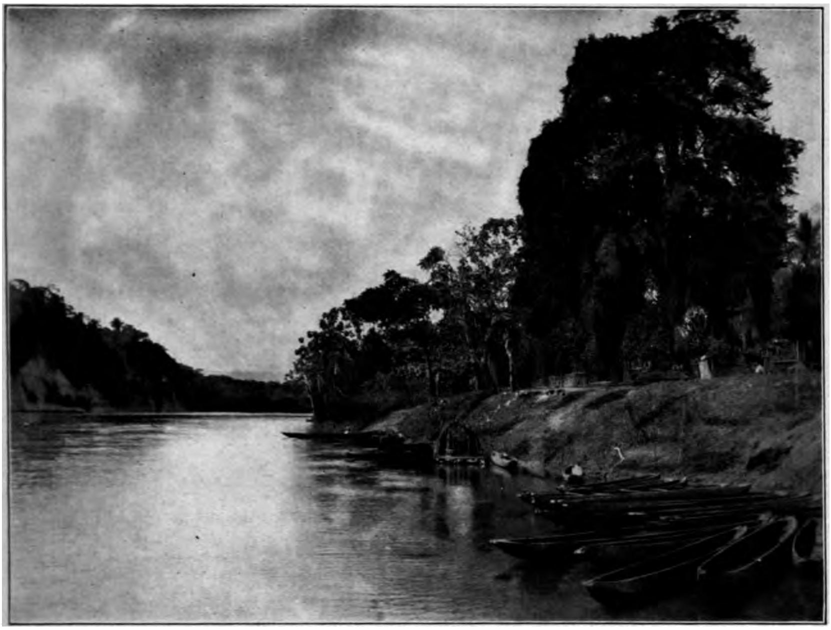
enlightened views are not shared by a majority of the ruling, or even educated, classes. Under shelter of the specious arguments that no port on the isthmus leads to any part of the mainland of the Republic and that even the department of Panama may suffer injury owing to the degradation of its two chief towns from the position of steamship termini, not a few intelligent Colombians contend that their country will derive no economic advantages from the completion of the Isthmian Canal. Repeated experience elsewhere in the development of transport facilities has proved how absolutely fallacious are arguments of this kind, but the Colombians cannot be very severely blamed for expressing confidence in them when even such shrewd business men as the managers of the United States transcontinental railways set an example. That the Colombians are not absolutely convinced upon the point is shewn by the fact that they are willing to forego all their objections to the scheme if the Administration and people of the United States will agree to bear the entire cost and hand over to the South American Republic, as full partner, a permanent interest in the enterprise.


THE STOCKS.

The Isthmian Canal is destined to be one of the most remarkable triumphs of modern engineering science applied to the annihilation of time and distance. By the strange irony of fate, however, it will pass through portion of a country more deficient in means of communication than any other settled and pseudo-civilised territory throughout the world. In the department of Panama are three open seaports, the two railway terminals, and Bocas del Toro, the centre of a large banana industry, to the north of Colon. Excepting the railway, it cannot be said to have advanced far in the development of internal communication since the early years of the Spanish occupation; indeed, in some measure, progress has been backward, for not a few of the paved roads built by the Spaniards in the first half of the sixteenth century are now overgrown and impassable. The isthmus, however, as compared with the mainland of Colombia, is a small country and a mere waste of forest and swamps. Yet, in the other eight departments, some teeming with mineral wealth, others blessed with fine pasture lands and rich soil capable of producing unlimited quantities of coffee, cacao, sugar and tobacco, there are little more than 300 miles of constructed railway and, outside the towns, not a dozen miles of decent road. In the interior, away from the railways and great navigable rivers, transportation is by pack mules and porters, travelling over bridle paths, just



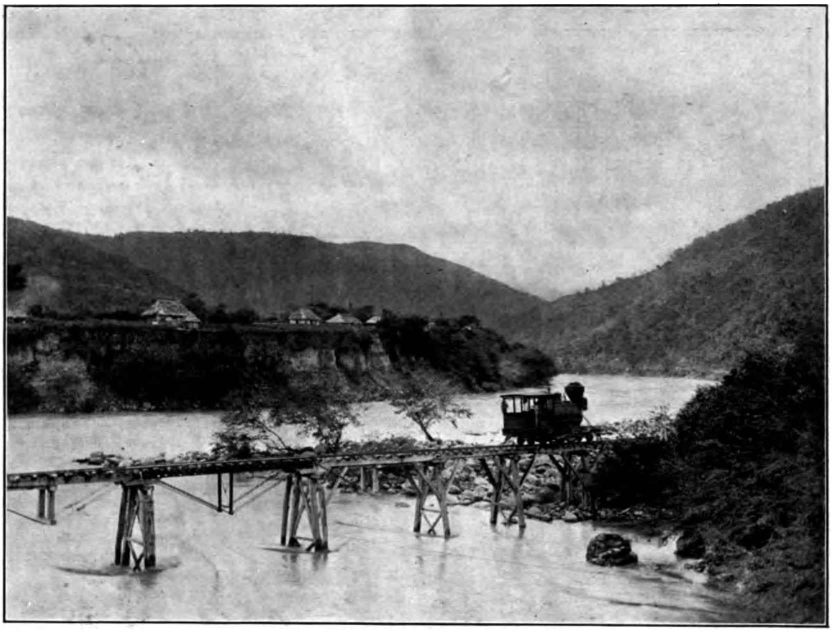
CACTUS AND FOREST JUNGLE.



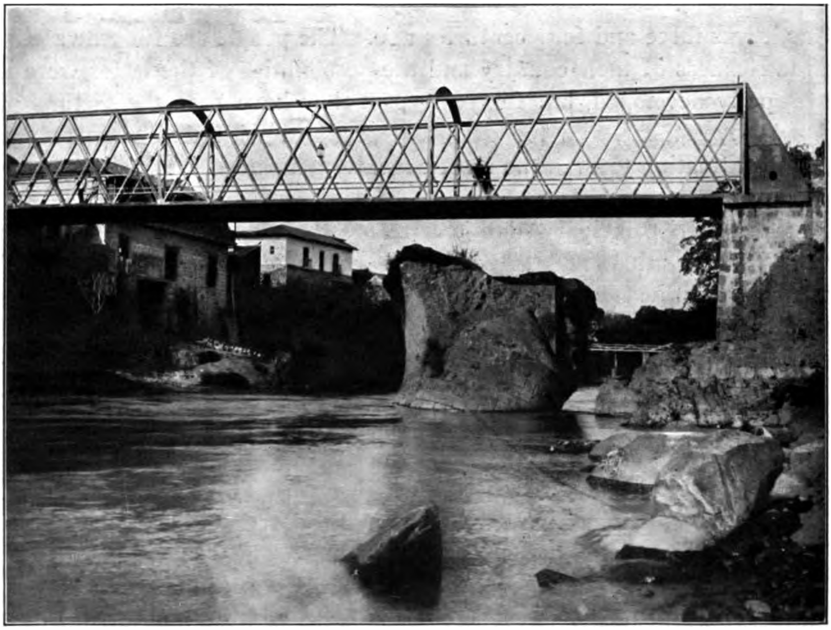
ON THE MAGDALENA RIVER.

as it was three and four centuries ago. The people are fully aware of the richness of their country and the possibilities of the latter were it properly developed, but for years past they have been the victims of bad government, and too generally occupied with civil wars to pay much attention to even the most urgently demanded internal improvements.

The two principal Atlantic ports on the mainland are Cartagena and Barranquilla, and to them come nearly all the passengers and freight destined for the interior via the river Magdalena, the main artery of Colombia's internal commerce. From Cartagena runs a line of railway, 66 miles in length, the property of an American corporation, to the port of Calamar, situated on the Magdalena. Barranquilla, which is also on the Magdalena, lies at a short distance from the coast, and is connected with Puerto Colombia, better known as Sabanilla, by a railroad 28 miles in length. This railroad and the pier at Puerto Colombia are worked by the Barranquilla Railroad and Pier Company, Ltd., a British undertaking. Thus, by either of these two lines, the Magdalena can be reached. From the coast to Honda, where the so-called Lower Magdalena ends, and the mule road to the capital begins, lies a stretch of river about 600 miles in length, which



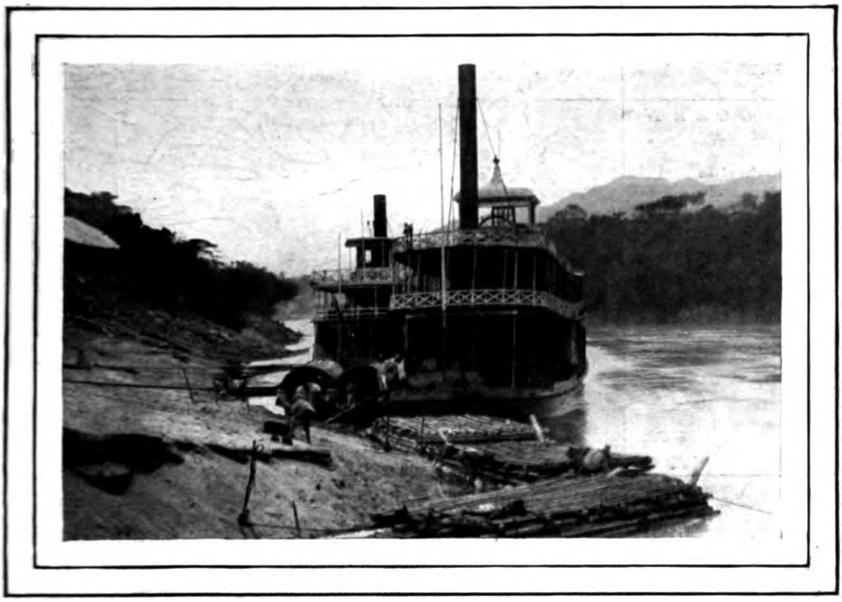
RAILWAY BRIDGE, HONDA.



A RUINED BRIDGE AND ITS MODERN SUCCESSOR.

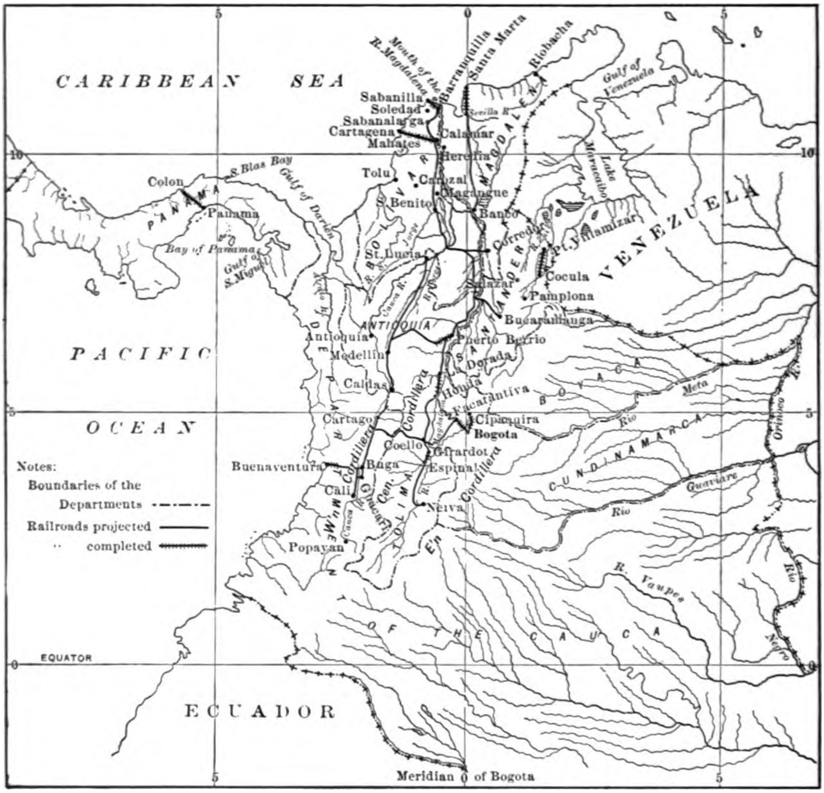
is operated mainly by two companies, Colombian and American. In normal times, the river steamers accomplish the distance between Barranquilla and Honda in six to seven days for the up, and four days for the down journey; but not infrequently, during periods of civil commotion, the passage from the coast has occupied from three to four weeks.

From Honda to Bogota there remains a mule journey of three days, over a track which, in comparison with the average Colombian "road," may be described as easy. As a matter of fact, it offers, during the best of times, very serious impediments to the transport of merchandise, and, when the country is disturbed, is usually infested by bands of guerillas. The expense, also, is considerable, for the cost of carrying a mule load from Honda to the capital rose from 25 pesos (equivalent to £1, at 500 per cent. exchange) before the outbreak of the last war, to 4,000 pesos Colombian currency (at exchange of 5,000 per cent. equivalent to £1 12s.) during the progress of the struggle. Since the declaration of peace, the demands of the muleteers have somewhat abated, but throughout the country transport charges of every kind are considerable higher than was the case a few years ago.



RIVER STEAMERS.

Another railway touching the Atlantic coast is that which runs from Santa Marta to the Sevilla river, a distance of 46 miles. This



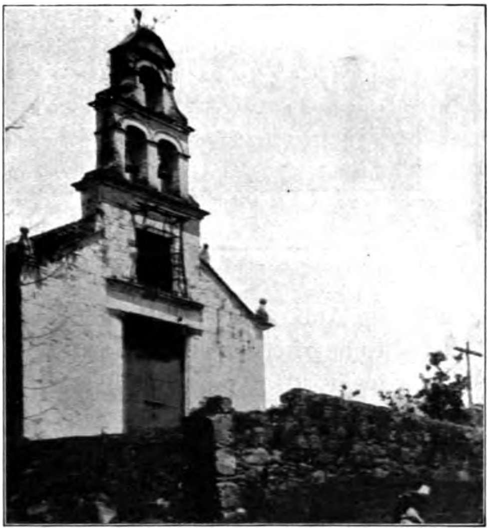
MAP OF THE REPUBLIC OF COLOMBIA.

belongs to a British company, and may some day be extended to Banco, on the river Magdalena. On the slope of the Western Andes, an American corporation has in operation a short line of railway, known as the Causa, an extension of which southward to Cali has been spoken of for many years. Other railways actually completed or projected, will be found marked on the map which is included in the present article. It is noteworthy that not ten miles of railway have been added during as many years to the means of communication throughout this vast territory, and that with a single exception, all the projected new lines and extensions were planned a decade or more ago.

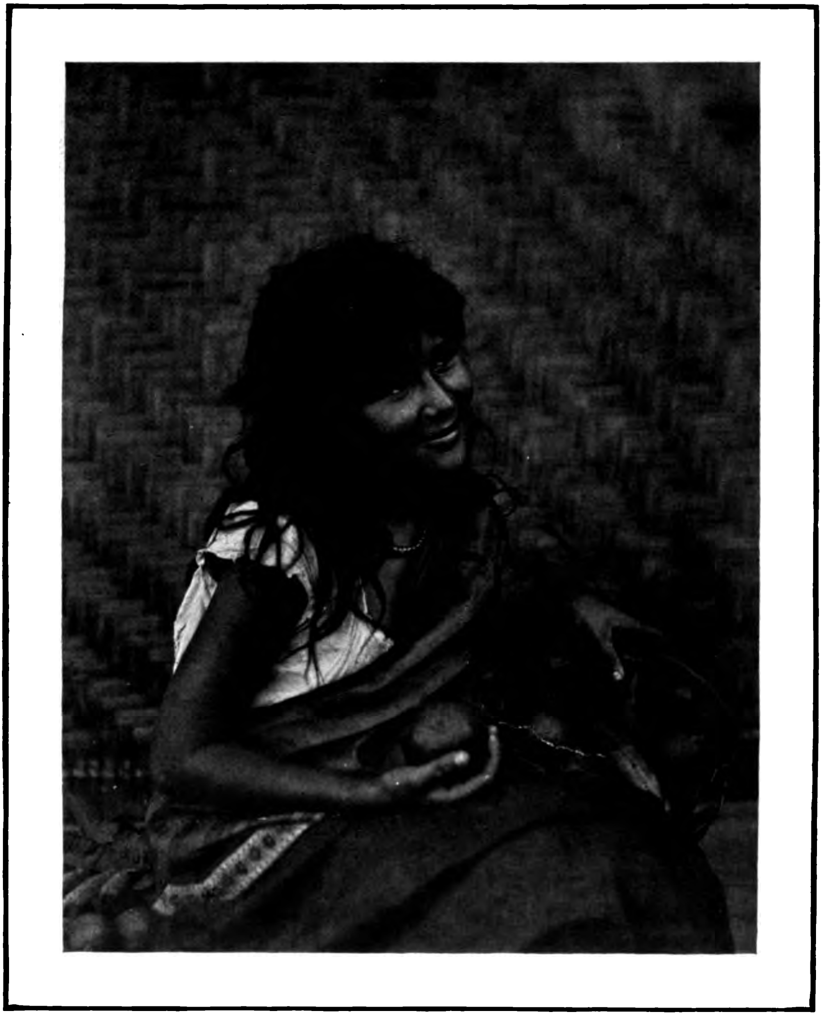
With a return of public confidence, begotten of reasonable pros-
of even a few years of internal peace, there is no doubt that these
r suspended enterprises would be actively proceeded with.
that this time, long hoped for in the Republic itself and by
wishers abroad, is near at hand, and some encouragement may

LAND AND WATER TRANSPORT—THE OX WAGGON AND THE DUGOUT.

be possibly derived from the fact that within recent months there has been granted by the departmental government of Antioquia to two American miners, Messrs. J. T. Bryan and Charles L. Wright, an important concession for the construction of a railway from St. Lucia, on the frontier of Bolivar, along the valley of the Rio Porce to Medellin, a distance of 180 miles, and thence along the same valley to the source of the Porce and to a termination on the frontier of the department of the Cauca. An idea of the importance of such a line to the department of Antioquia, rivalling that of Tolima in the number and value of its rich gold and silver mines, may be gathered from the fact that it is three days' journey on mule-back from Medellin to the terminus of the present Antioquian Railway, which unites the port of Puerto Berrio with the Magdalena. This is all that now exists of the old Punchart-Mac Taggart scheme, which was found to present many interesting but not overwhelming engineering difficulties, for connecting by railroad Medellin and the Magdalena. The latest proposed railway—in combination with the project for

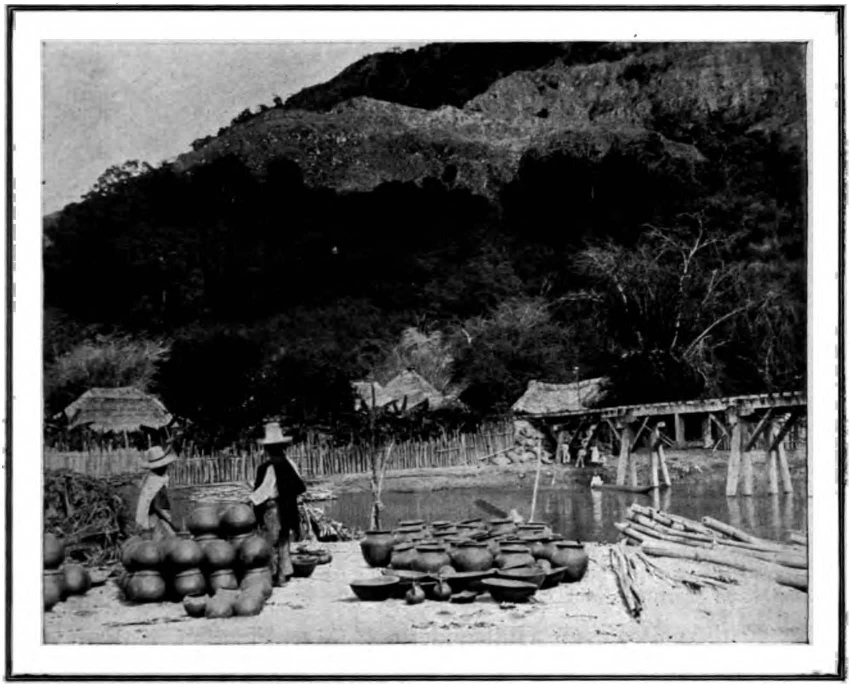


OLD CARMELITE CHURCH.



A FRUIT SELLER.

connecting Antioquia with Buenaventura, on the Pacific Ocean—could not fail to be of enormous benefit to the Republic. By means of these enterprises, roads to two oceans would be opened from the coffee regions of Condinamarca, the emerald mines of Muzo and Coscuez, in the department of Boyaca, the pastoral and industrial districts of Tolima and the Cauca, the commercial centres of Medellin and Manzalas, and the rich mining regions of the Western Andes, Tolima, and Cauca. At the present time, both silver and gold is being produced in considerable



NATIVE POTTERY READY FOR THE MARKET.

quantities by various British and other mining companies, between whom and the State and federal government amicable relations usually exist. Although during late years work by many of these companies has been frequently suspended, owing to political disorders, their average aggregate output is by no means insignificant. As individual examples of mining activity, I may mention that the gross returns from the Colombian Hydraulic Company's mine at Malpaso, Tolima, from 1873 to last year, were £286,000, while those of the Western Andes Company, an associate enterprise, at Marmato, in the centre of the richest gold district of the Cauca, were £790,000. Than Colombia there is no country in the world where railways—and internal peace—are more urgently required. It is well-populated, rich in agricultural produce and mineral wealth, and brimful of industrial possibilities. Its early development, both directly and in indirect fashion, depends almost entirely on the construction of an inter-oceanic canal through the Isthmus of Panama; and whether or not the Colombian adversaries of that enterprise are sincere in contrary belief, it is very certain that every intelligent foreigner who has lived in or possesses practical knowledge of the Republic is absolutely convinced upon the point.

THE COAL-MINING INDUSTRY OF THE UNITED KINGDOM.

By R. A. S. Redmayne.

HISTORICAL REVIEW OF THE DEVELOPMENT OF BRITISH COAL-MINING.

From the very beginning of the use of mineral fuel, Great Britain has been pre-eminent through her coal resources. They have been the foundation of her enormous expansion as a manufacturing power, and of an export trade which has carried her commerce right around the world. Whatever the future of the United States as a world's workshop and a world's fuel producer, the coals of Wales will long remain the standard of comparison, both as to price and quality. This gives universal importance to Professor Redmayne's comprehensive review of British coal mining, of which the first paper appears below. It has hardly less importance and interest for the light it throws on the broader aspects of the labour question. It is an impressive demonstration of the fact that the progressive introduction of labour-saving machinery has resulted in a constantly parallel rise in the condition and the prosperity of the labourer.—THE EDITORS.

IN 1860, Professor Hull undertook the calculation of the quantity of British coal, in 1863 Sir W. Armstrong drew attention to the question in his address to the British Association, and in the year 1865, Professor Jevons published his well-known book on "The Coal Question," since which time the subject of the duration of British coal supplies may be said to have remained a burning question. In spite of some inaccurate statements and erroneous contentions, Professor Jevons' work will always remain an important contribution on the economical side of the question, and must ever be regarded as being the first attempt to treat fully this important subject. It is thirty-six years since the first Royal Commission was appointed to investigate the probable quantity of coal existing, and other points germane to the question of coal supplies in the United Kingdom. And now another Royal Commission is sitting, having been appointed to undertake a similar though somewhat more extensive enquiry.

In order to have a clear perception of the present, and gauge the potentialities of the future, it is imperative that we should possess a knowledge of the past. This is as true of any branch of applied science as it is of commerce, and in the coal trade, the paramount industry of Great Britain, we have a close combination of these two.

Authorities are not agreed as to the date when coal was first used in Britain as fuel. It is not unlikely that some of the supposed allusions to "coal" in early manuscripts relate to the use of "charcoal," the "colliers" to whom grants of land were made being none other than charcoal burners. So passing over such dubious references, we find the first substantial mention of coal mining in the records of Holyrood and New Battle Abbeys, which show that coal was dug on the south shore of the Firth of Forth before the end of the reign of William the Lion (1200 A. D.). However, the year of the signing of Magna Charta would really mark the birth of the coal trade. Coal then appears to have passed into the hands of subjects along with peat, etc., as a mere surface material not worth mentioning. From this event which gave security of property, coal may be said to have been worked and sold as an article of commerce.

Considerable developments appear to have taken place in the reign of Henry III, and coal came to be worked in most of the coalfields of Great Britain. Turning for instance to the Great Northern coalfield (in Northumberland and Durham)—which has been the nursery of the industry, and in which at the present day will be found collieries that, in point of equipment, output, and management as well as amenities of labour conditions, are unsurpassed in any other mining district in the world—we find about the year 1236 a grant was made to the monks Adam, Alan, and Richard de Camhus, of land on the coast in the vicinity of the present town of Blyth, in which was included amongst other things the right of gathering sea coal (carbone maris) on as much of the shore as belonged to their grant. This is the same place as the modern *Cambois, and the collieries there, owned by the Cowpen Coal Company, now annually raise about one million tons of coal. Three years later Henry III granted a charter to the citizens of Newcastle giving them the right to dig coals in the Castle Field and Firth. The first mention of coal in the neighbourhood of the Midland Metropolis is at Walsall, where, in the time of Edward I, Margery la Rous, lady of the moiety of the town of Walsall, granted to Richard Morteyn and his heirs a moiety of the profit of each manner of mine of sea coal as well as of iron.

These references taken from a number will serve to show that active coal mining, though as yet most primitive as to its methods, was being entered upon throughout the land. The forests were dwindling and coal would be required for burning lime, for building purposes and for smithy work. That coal was also being used for household purposes is shown by the fact that it was imported into London from Newcastle about 1257, though like any other innovations before and

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* Pronounced "cammus."

since that day, its introduction was not received with universal pleasure, for we read that the Nobles and Commons assembled in Parliament complained against its use as a public nuisance, corrupting the air with stink and smoke; so that its use was prohibited in London by Royal Proclamation in 1306. However, the loyal (!) citizens paid no heed to the injunction and wisely continued to use the new fuel.

Coal and other minerals were naturally first worked in hilly districts, where the deposits outcropped, and in these early days of coal mining, the working of the coal was carried on by means of an "adit" driven into the seam or by "bell pits" sunk near the outcrop; these were small holes or shafts 3 or 4 feet in diameter put down through a few feet of overlying strata to the seam of coal, and then widened out so as to allow of the excavation of as much coal as possible without causing the overlying strata to fall in; similar, in fact, to the bell pits in Sussex sunk in pre-historic times to obtain flints for the making of stone implements.

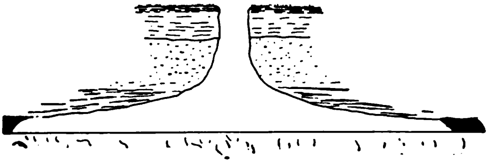

FIG. I. BELL PIT.

In the fourteenth century, the coal was mined by the shaft and adit method (Figure 2); the adit, which was used to draw off the water, was driven into the side of a hill; the miners by wooden picks tipped with iron drove narrow passages or galleries in the coal seam, and loaded the coal by means of wooden shovels into wicker baskets (called corves), which were either carried or placed on wooden sledges and drawn by manual labour to the shaft bottom, where by means of a jack roll worked by hand it was hauled up the shaft, or in some parts, the Scottish mining districts for instance, it was carried up the shaft on the backs of women. When difficulties presented themselves, such as lack of air or excess of water, the workings were abandoned and a fresh pit sunk—to the depth of a few fathoms—some little distance away. Old shafts can still be seen in ancient mining districts which show the area of the workings to each shaft to have averaged about 10 to 11 acres.

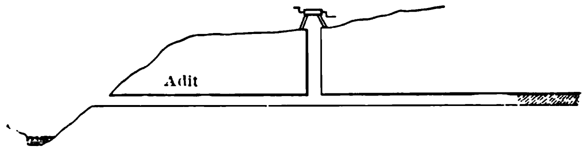

FIG. 2. SHAFT AND ADIT.

But little advance was made in the art of mining during the fifteenth, sixteenth, and seventeenth centuries. Water was the great difficulty, the depth and extent of the workings being limited for the most part by the level at which free outlet for the water could be obtained through day drifts (see Figure 2 and 3), and it is worthy of note, in view of the present enquiry into the extent of available resources of the coal fields of the United Kingdom by the Royal Commission on Coal Supplies, that in the year 1610 it was stated in Parliament that the coal mines on Newcastle-on-Tyne would not last out the term of their leases of twenty-one years, owing to the maximum depth having been reached.

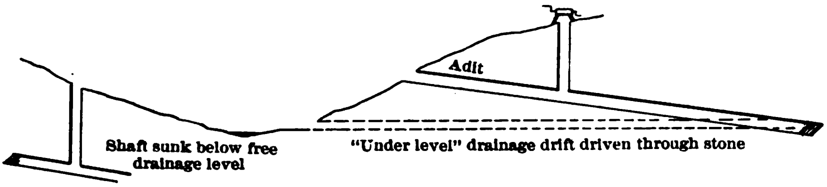
Adit
Shaft sunk below free drainage level
"Under level" drainage drift driven through stone

FIG. 3. STAGES IN THE ADVANCE OF MINING.

Attempts were made about this time to raise water in several stages by chain pumps operated by water wheels in the manner illustrated in Agricola's "De Re Metallica" (Figure 4), or by horses; and whim gins worked by horses were substituted for jack rolls in raising the coal.

The manner of raising water from coal mines in Staffordshire has been described by a writer* of the time (1686). He says:—

> "The less gin they call a jack, which is turned by men or horses, as necessary, but the gin is always worked by horses, which likewise is two-fold, either by chain or barrel; the chain is made with leather suckers upon it at little distances; which bring up water and discharge into a trough; the gin by barrel whereof one always goes up as the other goes down, will raise great quantities of water if it be worked day and night."

The ventilation of the mines was most primitive, and there can be no question that as the workings advanced further away from the outcrop and the depth from the surface increased they would be much troubled with fire-damp; but for the first account descriptive of the difficulties encountered in this respect we are indebted to Mr. Roger Mostyn, in a paper prepared by him for the Royal Society in 1677. It was when opening out a new colliery at Mostyn in 1675 that fire-damp was first heard of in that district, and the writer of the paper

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* Dr. Plott, professor of chemistry, University of Oxford, in his "Natural History of Staffordshire."

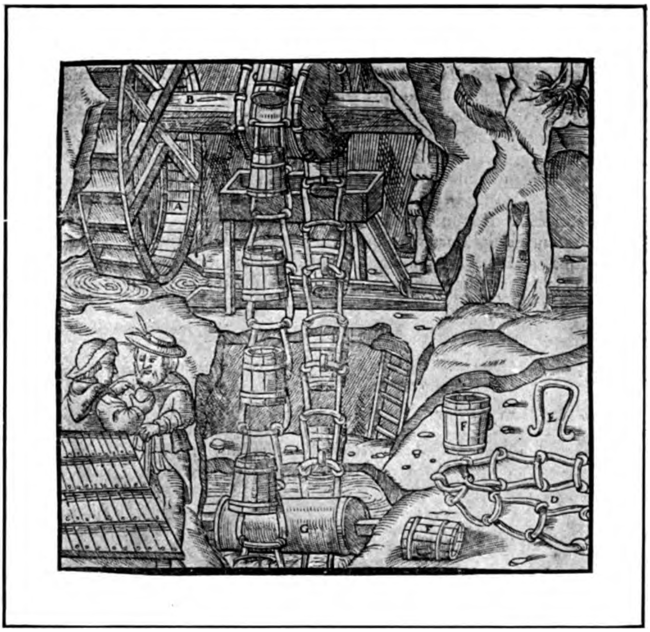

FIG. 4. DRAWING WATER UP A SHAFT BY MEANS OF A CHAIN AND BUCKETS.

From an old print.

tells how that after the workings had proceeded a good distance underground, fire-damp gradually begun to "breed," but was little feared by the workmen who toyed with it with their lighted candles until one of their number was badly burned by it, after which the collieries selected a man from among themselves who being "a resolute man of purpose," was sent down the mine some time before them every morning clothed in his worst rags saturated with water; this courageous individual crawled forwards towards the fire-damp holding a long pole before him, to the end of which were attached one or more lighted candles, and therewith fired the explosive mixture. This came to be the usual mode of dealing with fire-damp—a very dangerous mode; the man who did the "fiering" was termed the "fireman," and so was originated a class of men whose duty it is at the present day to inspect the workings before entrance of the workmen, and who in some mining districts are still designated "firemen," and in others are known by the name of "deputies" (deputy overmen). For a graphic description of an explosion at Mostyn Colliery, the earliest account extant, the reader is referred to the paper alluded to above.

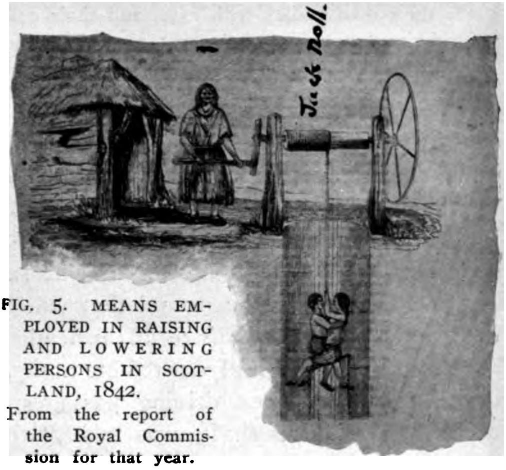

FIG. 5. MEANS EMPLOYED IN RAISING AND LOWERING PERSONS IN SCOTLAND, 1842. From the report of the Royal Commission for that year.

Grey, the earliest historian of Newcastle, writing in 1649, said the coal trade only "began not past four score years since; coals in former times was only used by smiths and for burning of lime," although we have seen that it was used as early as the fourteenth century for domestic purposes in London; but there is no doubt that the reign of Queen Elizabeth saw considerable widening of the demand for coal.

Several attempts were made in Staffordshire in the early part of the seventeenth century to make iron with pit coal, and in 1619, that great benefactor of the coal and iron industries, Lord Dudley, succeeded in accomplishing this, and at his first trial, by means of coal, successfully smelted iron at the rate of three tons a week. It is possible, too, that the expansion of the trade was assisted by the invention of coke, alluded to in those days as the "charring" or "charling" of "sea-coal," a process which was patented in 1620 by one Hugh Grimsby and also about the same time by Sir John Hacket in conjunction with Octavius de Strada, so that said the latter, it "might be used in houses without smell or smoke."

Tho coal trade, however, does not seem to have been enjoying universal prosperity in the middle of the seventeenth century; doubtless it was experiencing one of those cycles of depression, due in all probability to over-supply, which have proved so characteristic of the more recent history of the industry. Grey in his "Chronographia" published in 1649, says:—

> "Many thousands of people are employed in this trade of coals, many live by working them in pits, and many live by carring of them in wagons and waines to the river Tine; many men are employed in carrying the coals in keels from aboard the ships; one coale merchant employs 500-1000 in his works of coale—yet, for all his labour and care, and list, can scarcely live of his trade: nay, many of them have consumed and spent great estates, and dyed beggars, and our coal miners they labour and are at great charge to maintain men to work their collieries. They waste

> their own bodies with care, and their collieries with working, the kernel being eaten out of the nut, there remaineth nothing but the shell; their collieries is wasted and their monies is consumed; this is the uncertainty of mines—a great charge, the profit uncertain."

Not an inapt epitome of the views of a present-day coal owner when the trade is depressed. "Master Beaumont" is also mentioned by the writer from whom we have quoted as having "adventured £30,000, expended on rare engines &c. and consumed all his money and rode home on his light horse," and he sapiently remarks "There's a swarm of worms underground that will eat us all before their time. They may find some *ignis fatuus* instead of a mine."

From this time and from remote antiquity, the method of breaking down the stone when driving passages through hard rock (stone drifts) and sinking shafts was to heat the rock with fires and pour water on it and so split it, and it is interesting to note that traces of breaking rock have been found in the ancient workings of the Rhodesian gold mines. Gunpowder was first used for blasting in the metal mines of the Mendip Hills (1683), but not until 1719 was it taken advantage of in coal mining in the United Kingdom, when it was used for sinking through hard rock in Somersetshire. Its use enabled more difficult mining operations to be undertaken, and the invention of the atmospheric engine by Newcomen in 1710 (see Figure 6) introduced new and improved methods also, changing in fact the whole aspect of the industry. Until that time 60 fathoms was about the maximum depth of shafts—their diameter 7 or 8 feet, the workings seldom extending beyond a radius of 200 yards from the shaft. But in 1760 Walker Colliery on the Tyne was sunk to the depth of 100 fathoms to the main coal seam, a medal being struck to commemorate so unprecedented an event, and in 1763 a pumping engine was erected having a cylinder 72 inches in diameter and 10 feet 6 inches long.

It was not, however, until the year 1780 that the atmospheric engine was applied—at Willington Colliery in Northumberland—to drawing coal up the shaft. And the first Boulton and Watt engine with a closed-top cylinder was erected at St. Anthonys, near Newcastle, in 1790. It is remarkable that some of these antiquated types of engines are still to be seen at work at mines in South Staffordshire.

The difficulty of procuring sufficient light whereby to work in "fiery" mines before the era of the safety lamp can be easily imagined. The choice would lie between the dim light obtained from the phosphorescence of suspended fish skins, and the possibility of being burnt by the ignition of fire-damp, until the invention of the steel mill by

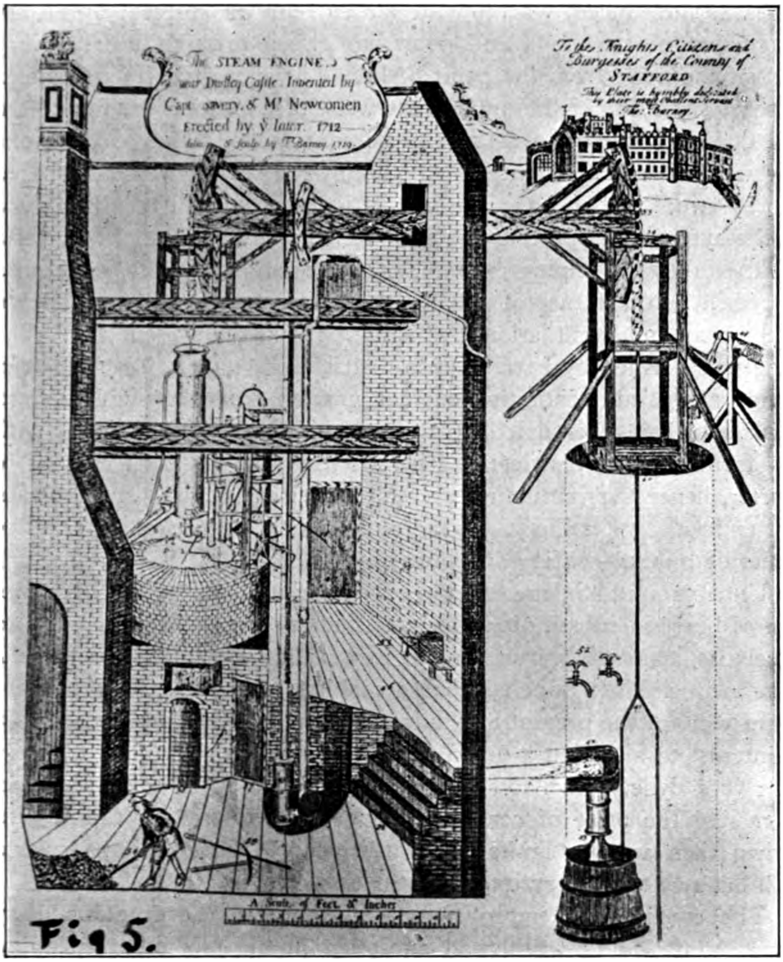
The STEAM ENGINE
near Dudley Castle Invented by
Capt Savery, & Mr Newcomen
Erected by ye later 1712
Delin & Sculp by Tho Barney 1719
To the Knights Citizens and
Burgesses of the County of
STAFFORD
This Plate is humbly dedicated
by their most Obedient Servant
Tho: Barney
A Scale of Feet & Inches
Fig 5.

FIG. 6. THE FIRST STEAM ENGINE.
Erected at a coal pit in Staffordshire in 1712. An old print.

James Spedding in 1760—a machine consisting of an iron frame supporting a steel wheel which was made to revolve against a flint, producing thereby a shower of luminous sparks; but even this contrivance appears not to have been very safe, for an explosion due to its use is recorded as having occurred at the Wallsend Colliery.

Great improvements were also being made in the ventilation of the underground workings of the mines: hitherto it had been customary to ventilate only the working face by the one continuous current: now, however, (1765) the method known as "coursing the air" was introduced, whereby the air current was forced, by an arrangement of stoppings and doors, to sweep through nearly every part of the mine from the point of inlet (downcast shaft) to its exit (upcast shaft).* If the air current was taken up one row of pillars and down the next it was said to be courses "one and one," if one row was missed and it was taken back by the second it was "coursed two by two," and so on. The ventilation was still further improved by the system of "splitting the air," which was the idea of Mr. John Buddle (1807), a mining engineer of great note in his day, sometimes described as the father of the Northern coal trade; this was known as the compound ventilation, and is in vogue at the present day. The mine was divided by barriers into districts or "panels," each district having a separate ventilating current split off from the main current, in place of being ventilated by a current perhaps already fouled with gas from another district; the length traversed by each current is shorter, hence the ventilating pressure required is less—an important matter in a large colliery. It therefore meets the two great requirements of mining—safety and economy.

Underground haulage had already been improved by the introduction of horse in substitution of manual labour for pulling the coals to the shafts, and coals were selling at Newcastle (1765) at from 12 shillings to 15 shillings per chaldron (a chaldron was equal to 3 tons).

In view of the present day industrial combinations and trusts, it is of interest to note that a union of colliery owners shipping coal from the rivers Tyne, Wear, and Tees, was formed in 1771, with the object of raising the price of coal to consumers by restricting the output, known then as the "limitation of the vend." This alliance existed with but few temporary interruptions until the year 1845.

The considerable improvements in the steam engine made by James Watt led to further advancement in the method of winning and working at the commencement of the nineteenth century. And the employment of coal in the manufacture of gas (about 1803) gave a great impetus to the coal industry. Tubs or colliery trams were invented by a colliery viewer (manager) named Carr in Yorkshire in 1797—as also guides for shafts; the trams held 5½ to 6 cwts., and ran on small wheels on wooden tramways, and later on rails, but it was not until about 1836 that the invention was generally adopted throughout Britain. The replacement of the wicker corf by an iron cage for holding the trams in their transit up the shaft soon followed.

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* There was but one shaft, the downcast and upcast airways being compartments formed by wooden bratticing in the same shaft.

Deeper shafts and more extensive workings brought in the era of big colliery explosions, of which unfortunately we have not yet seen the end, though an appreciable diminution is noticeable during the last decade, due doubtless to our better knowledge of the part played by coal dust in such catastrophies. Repeated disasters in the pits led to the formation at Sunderland in 1813 of a "society for the prevention of accidents in coal mines," and it was the members of this society who were instrumental in engaging the services of Sir Humphrey Davy in the investigation which culminated in 1815 in the invention of the safety lamp. Many safety lamps have since appeared, but the principle underlying their construction—other than those in which the light is electrical—is the same, viz., that if a gas flame is brought in contact with a cool material the flame is extinguished and the gases pass away unburnt. Sir Humphrey Davy secured this object by surrounding the flame of the candle with a cylinder of wire gauze, (the mesh of which contained 784 apertures in a square inch), about 1½ inches in diameter and 7 inches high, covering the top with a cap of the same material; the air could pass in freely, but should gases

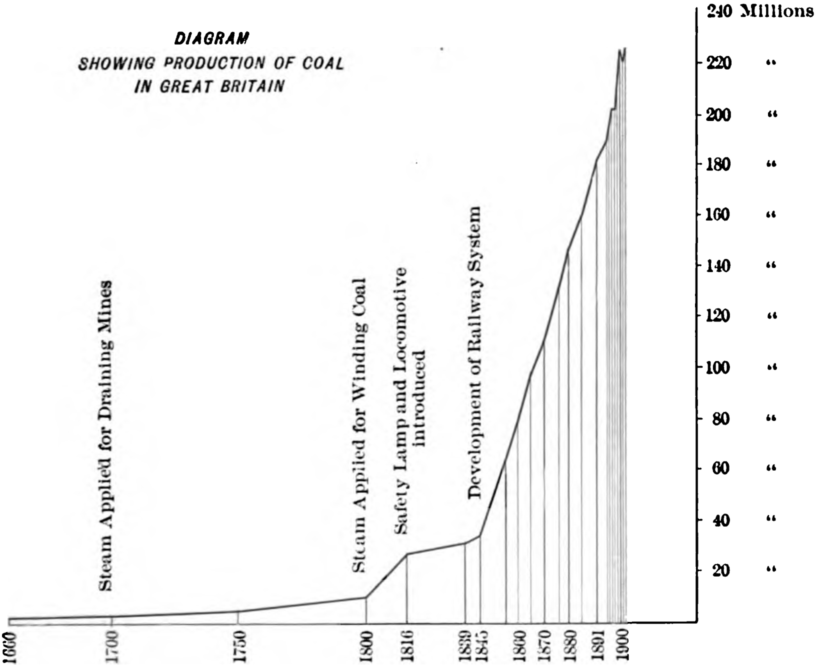


FIG. 7. PRODUCTION OF COAL IN GREAT BRITAIN, 1660 TO 1900.

enter and fill the interior with flame, as soon as the flame touches the gauze it is instantly cooled and cannot pass outside unless the gauze itself become red hot, or the lamp be rapidly moved or the inflammable vapour strike the gauze at a high velocity. This invention undoubtedly led to still further extension of mining operations.

The following table and the diagram (Figure 7), giving the output of coal for the United Kingdom at various stages of the history of the trade, shows how the augmentation was contributed to by the introduction of various improvements and inventions connected with the art of mining.

Year.	*Output of coal in tons (2,240 lbs.)*	*Authority.*
1660	2,148,000	Estimated by the Royal Commission on Coal, 1871.
1700	2,612,000	“ “ “
Steam applied to draining mines. Gunpowder used in mines.		
1750	4,773,828	“ “ “
Steam applied to drawing of coal. Development of the canal system (1760-1800).		
1800	10,080,300	“ “ “
Coal used for manufacture of gas (1803).		
1816	27,020,115	Estimated by Samuel Salt.
Invention of safety lamp.		
1845	34,600,000	Estimated by J. R. McCulloh.
Steam boats and the development of railway system.		
1855	64,307,000	Estimated by Roy. Com. on Coal, 1871.
1860	84,042,698	Official Returns.
1865	98,150,587	“ “
1870	112,875,525	“ “
1901	219,046,945	“ “
1902	227,178,140	“ “

As to the condition of the mine workers nothing has been said in this article, nor is it proposed to enter into a detailed consideration of this side of the question, but it may not be generally realised that in Scotland in the middle of the eighteenth century colliers were working under laws by which they were practically slaves; able bodied men were paid 10 pence per day for hewing coal, the womankind acting as bearers in carrying the coal out from the workings and re-

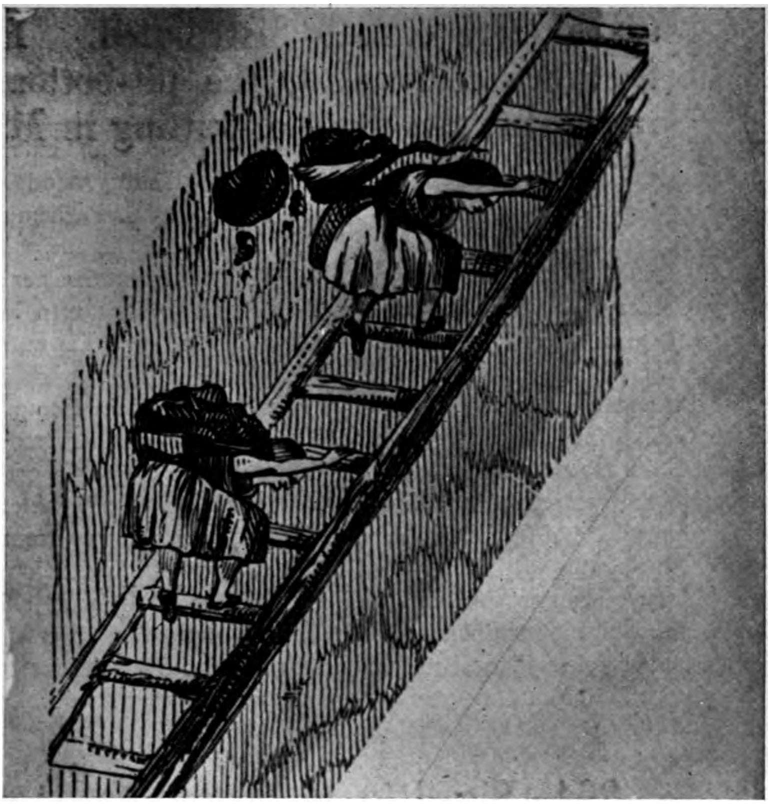


FIG. 8. WOMEN CARRYING COAL UP A SHAFT IN SCOTLAND.
From Report of Royal Commission, 1842.

ceiving but 3 pence a day. The workers, forming part and parcel of the concern, passed from owner to owner with the colliery as so many chattels. In 1778 a law was passed which enacted that this state of life slavery should come to an end, the emancipation to be gradual; but it was not until 1799, when another act was passed, that their complete freedom was granted to them. It is only right, however, to point out that the pay and conditions of employment of the mine workers in other parts of Britain were in advance of those of Scotland, and that although women were employed about this time in the majority of mining districts in underground haulage, it was only in Scotland that they were made to carry coal up the shafts.

The middle of last century may be regarded as a transition period in the history of coal mining in Britain. The ventilating furnace was already in operation, and mechanical ventilators were being introduced. Hempen ropes were being replaced by those constructed of iron wire (1840), and underground haulage soon came to be effected by mechanical means. The railway system was developing, and steam-driven machinery was coming to be universally applied to mining operations, enabling collieries to be worked to greater depth and extent, and increased individual outputs to be obtained. Underground inspection by Government officials was introduced by Act of Parliament in the year 1850, and in 1860 further legislation resulted in the passing of the Mines Regulation and Inspection Bill. The great disaster at Hartley Colliery (Northumberland) in 1862, whereby 204 men lost their lives, showed the need of having a second and separate outlet from the mine, and the Act compelling the sinking of two shafts became law as a consequence. Ten years later (in 1872) the Comprehensive Coal Mines Regulation Act was passed, since which much stringent State regulation has been imposed, with the view in a great measure to the protection of the persons and interests of the miners. Socially, morally, and financially the status of the workers has greatly advanced during the last sixty years, and coal mining has developed into a branch of engineering requiring the services of the most skilful and highly trained engineers.

The next article will deal with the period covered by the last 30 years—the condition and state of the mines, the engineering developments, and the social and financial position of the workers.

A WOMAN DRAWING COAL FROM A LANCASHIRE COLLIERY, ABOUT THE MIDDLE OF THE 18TH CENTURY.

ELECTRIC TROLLEY VEHICLES WITHOUT RAILS.

By Emil Guarini.

Col. Stewart has recently and well pointed out in these pages (July, 1903) that the steel rail, rather than mechanical traction, is the more important element in the economy of haulage by motor vehicles. M. Guarini, however, takes up a special case only—that in which the density of the traffic is not sufficient to justify the installation of the railway, and yet some of the advantages of centralised power generation and electric traction may be realised while preparing the way for the fuller development by the tramway later.—The Editors.

ELECTRIC traction by means of the trolley, but without the steel-rail roadway, unites to the advantages of ordinary electric traction those of economy in the first cost of exploitation, and of better utilisation of equipment. It involves a far smaller outlay than a tramway or any form of traction requiring the steel roadbed, which in its installation and its upkeep, together with the support of its administrative staff, is so expensive that the undertaking as a whole sometimes becomes little or not at all remunerative.

It is not at all to be inferred from this that a traction installation on ordinary roads, taking current from ærial feeders but running its vehicles without the metal tracks, would be always and everywhere superior in economy to one employing rails for its way. The problem and its solution vary with each special case. Indeed, by reason of the much greater tractive effort required when a vehicle is not running on rails, the current demanded in such case is also much greater. It rises further as the road surface becomes poorer. If the current is supplied at a low net cost, as in some cases of hydraulic utilisation, this excess demand for power may not become a serious item in the account. It may be quite the contrary, on the other hand, if, as in many cities, the cost per kilowatt of electric power is very high.

There are other factors, also, which can not be left out of the count. By no means least of these is the necessity, in the case of electric traction without rails, for two metallic conductors in place of the one employed when, as in the railway, the return circuit is made by the steel rails. But here I seek indulgence in a digression. There are, among electricians, two parties on the question of earthing the return circuit. The first would abandon entirely, in traction work, the return by the

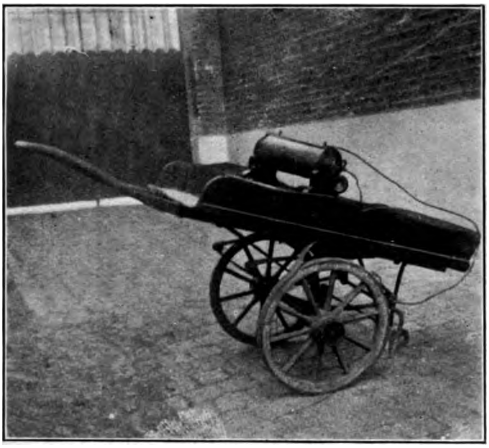


FIG. I. WIRELESS TELEPHONE APPARATUS.

rails and the ground, alleging as objection the resulting perturbations in telephone, telegraph, and other weak-current circuits. The second, very reasonably, in my opinion, are unwilling to renounce the economical advantage resulting from the use of the earth in place of an often very expensive metallic conductor. They would seek rather to discover and provide some means of correcting the disturbances of the feebler systems, and would adopt the earth return not only for electric traction lines, but for all electric power systems. The International Society of Electricians is applying itself to the solution of the problem.

I myself have quite recently verified a means which, I hope, at least, may serve to solve the question in the most complete and general manner. This means which I have tested is generally analogous to the three-wire distribution system. It consists in dividing the power current between two circuits, both earthed at every pole, the earth connections of the respective circuits at each pole having opposite polarities. If the intensity of the current is substantially equal in the two circuits, a very sensitive galvanometer placed in circuit with two earth connections close to those of the power circuits will not indicate any current (Figure 2). In other words, what is needed is to neutralise, by a charge of contrary sign, the charge which each ground of the galvanometer circuit (telegraph, telephone, etc.) receives from the current from the earth plate connected to the dynamo.

But how is return through the earth to be effected when the vehicle is in motion over the pavement—that is to say, on a roadway not laid with rails? The difficulty depends upon the tension of the current employed. Suppose, for instance, that the current taken from an overhead wire, after traversing the motor of a vehicle, leads to the metal tires of the wheels running on the roadway. Unquestionably that would be a very bad ground connection; but what do a few dozen ohms' resistance matter when the pressure is thousands of volts? I say thousands advisedly, for there is nothing startling in the statement after the Zossen-Marienfeld experiments, in which a current of 12,000 volts was used directly in the traction motors. I personally have made experiments in wireless telegraphy from a moving vehicle, using a telephonic receiver and, as return, the wheels of a truck resting on the street pavement (Figure 1). The tension was 30,000 volts. The aerial wire led first to the fine winding of a transformer and thence to the wheels. The telephone was in the primary of the transformer. At the intensity employed in the transformer there was no difference in intensity of the sound to be detected in the telephone, whether the grounding was through the wheels resting on the pavement or through a rod sunk deep in moist ground.

To return from our digression, let us take up the various applications of electric traction without rails—electric haulage or towage of boats, the electric omnibus, and the electric dray.

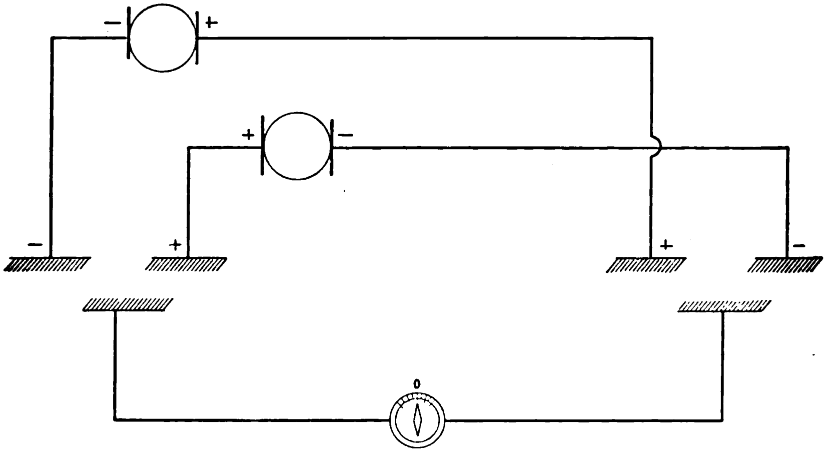


FIG. 2. METHOD OF CORRECTING DISTURBANCES CAUSED BY DYNAMO CIRCUITS.

For the movement of canal boats by electric power two systems are in use, both with many minor modifications; these are electric towage and electric haulage. The electric tow boat is far more economical than the steam. According to the calculations of M. Léon Gérard, the possible economy of the system amounts to 29,000 francs per year for 100 horse power employed 20 hours a day for 300 working days, with coal at 15 francs a ton (metric). As compared with haulage, it has the further advantage of reducing the cost of upkeep of equipment to a minimum, and that of upkeep of the tow path to zero. At a speed of 4 kilometres (2½ miles) an hour, there is no damage to the banks. At higher speeds the banks may be injured, on account of the bad lines of the boats; but if, as in the Merwede canal in Holland, the banks are sufficiently protected, towage requires no changes in the traffic movement and none in the bridges, quays, or other structures.

On the other hand, as compared to haulage, simple towing has the defects of lower efficiency (32 : 45, or even 32 : 65), of higher power requirements (3.1 : 2.2) and of higher coal consumption (3.37 : 2.75). But the upkeep of the towing path or roadway and of the rolling stock offsets the economy which haulage otherwise shows over towage.

The trials made by M. Gérard on the Charleroi canal in 1901, with a polyphase lateral line and small boats of 60 centimetres draught and 12 horse power, showed very good results. Although the towing craft was 25 metres away from the line, the trolleys worked perfectly and left the boat its perfect mobility. The speed was 10 kilometres (6.2 miles) an hour. The weak point was the efficiency. With screw and gearing it fell to 30 per cent. With large tow boats permitting direct coupling of the motor this might have risen to 38 per cent. The efficiency, in straight canals, might even rise to 80 per cent., if in place of simple towage use were made of cable-warping towboats, which furthermore are practical in handling and inexpensive in maintenance.

In fine, electric towage does not give an absolute solution of the question of electric traction on canals, but it may be advantageous in certain cases, depending on the locality and the traffic of the canal. In such cases it will undoubtedly spread by virtue of its superiority to any other method. It may be remarked further that nothing could be simpler than the considerable reduction of the installation costs of a towage system by the replacement of the return conductor by earthing the circuit. This can be effected by a plate immersed in the water.

Electric haulage, like electric towage, fails to furnish a final solution of the problems of canal traction. Three systems have been successively tried—the Köttgen rack system, the smooth rail, and traction without rails. Of these the last only belongs properly to our subject. Traction upon the bank and on a common roadway is certainly a more practical proposition than the rack system, as proved by three years' experience on the French canals (Gaillot system) and by that of one year on the Charleroi canal (Gérard system). The total efficiency may reach 75 per cent., but the art of the civil engineer must be called into play to make the application practical and its best possibilities realisable; for the profile of the canal, its state of upkeep, and the character of the road over which the haulage motor runs may vary the total result in the ratio of 1 : 3. The system has the general advantage of demanding less initial outlay.

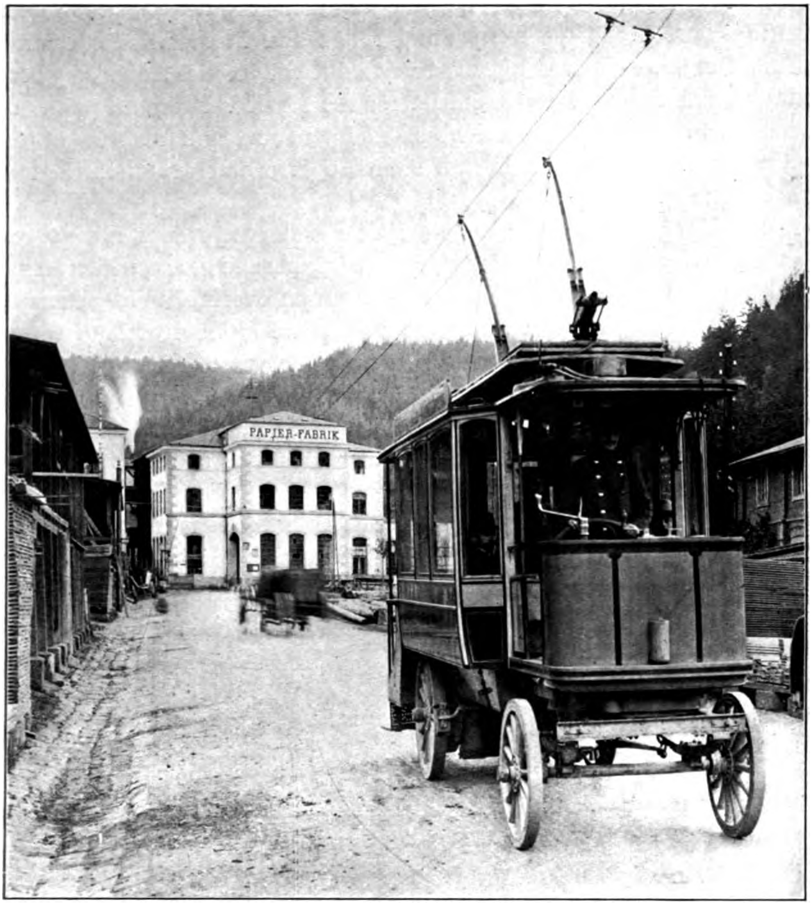


FIG. 3. ELECTRIC OMNIBUS (SCHIEMANN-SIEMENS & HALSKE SYSTEM), BIELA VALLEY LINE.

In the Charleroi experiments referred to above, the supply network received polyphase current at 6,000 volts, 40 periods. An electric central station supplied a stretch of 47 kilometres. The wheels, though of Martin steel, suffered rapid deterioration and serious deformation. In fine, traction on the tow path under the conditions prevailing on the colliery canals of Belgium has not equalled the hopes of its inventors. The demonstrated difficulties are removable, and arise from the character of the road surface. The experience gained led to trials of electric canal haulage on a track laid with smooth rails, but these results are somewhat outside of our present scope. The comparison of the figures, however, sufficed to show that electric haulage on the canal bank could be successfully employed only if the roadway for the motor vehicle were broad, perfectly built, rolled and macadamised, costing in the total more than a light railway sufficient for the 2,000 or 3,000-kilogramme motor trucks requisite for the service. From all points of view—economy of installation, of maintenance, and of current requirement, canal traction on rails seems superior to traction on the tow path surface.

But if electric traction on navigable waterways does not appear yet to have emerged from the phase of experiment, electric traction without rails but with current supply from an overhead wire seems to have established itself definitely as a practical method of land transportation. It promises even a new activity for that industry which in our era has seen so wide an extension. Not all the many transportation enterprises have been fortunate, but their multiplicity shows that facility of communication is one of the great needs of modern society. It is not sufficient, however, to prove the existence of a need; it is requisite further, in commercial exploitations, to measure the importance of that need and proportion the financial effort thereto. This rule has been at times overlooked, and lines have been built at a cost which it was beyond their physical power to repay. The economic error has been the idea that the rail has always been considered the essential basis of any public transportation system. But the construction of a permanent way laid with rails necessitates a large capital outlay, demanding in its justification a volume and density of traffic which often does not exist.

When the automobile came upon the scene, it was thought that here would be found the proper solution for lines of light traffic. Unhappily, the steam boiler, the steam engine, and the oil motor accommodate themselves but ill to the difficulties inherent to road traffic with vehicles of large capacity. On the other hand, the electric motor is the motor *par excellence* for automobilism; it is incontestably the cheapest to maintain; it is free from vibration; it may be hermetically sealed. But this motor demands a source of energy; if this energy is supplied by accumulators, the weight is immensely increased, and to the maintenance costs are added those occasioned by the battery. Naturally, it was sought to utilise the special qualities of the electric motor while avoiding the defects of the storage battery. The tramway with its tracks answered the question by taking the necessary power from an overhead wire connected with the central station. But the method which is entirely simple in the case of the tramway, whose path is fixed and invariable, is inapplicable to the automobile, which must be unconfined and free in its movements to avoid the obstacles of the road. It was first proposed to make use of little carriages, rolling on the trolley wire, connected to the vehicle by light flexible cables and towed by these. This solution was not practicable. The little trolley carriage, dragged along by an outside force which was continually varying its direction, became jammed, derailed, breaking its connecting cable or damaging the trolley wire. This difficulty has been met in two ways—by using rigid trolleys, and by making the trolley carriage automobile.

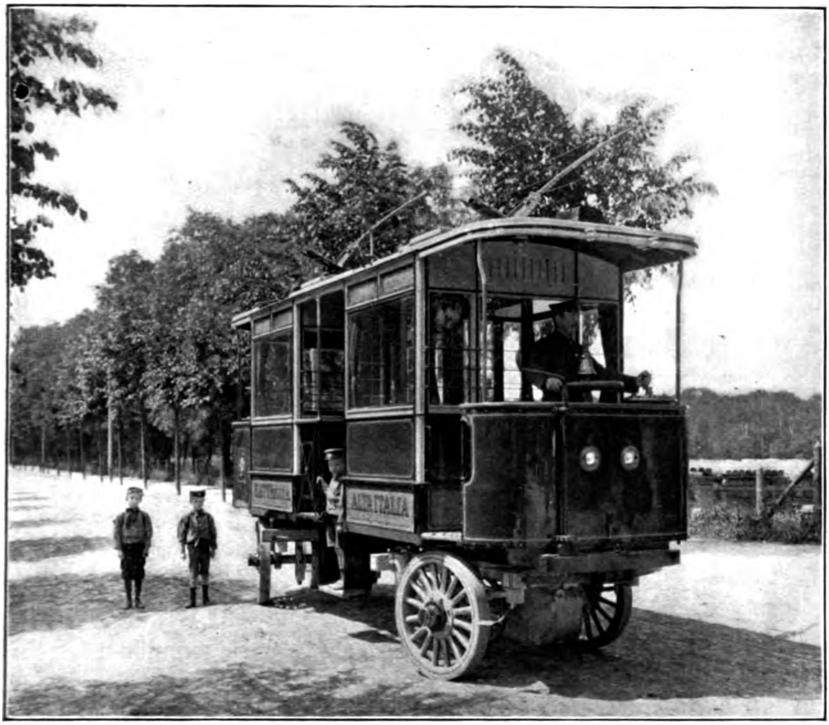


FIG. 4. ELECTRIC OMNIBUS OF THE SOCIETA ALTA ITALIA.

Under these conditions the system has been practically developed, and possesses, besides the general advantages of electric traction, that of being applicable in cases where a track could not be laid—where the curves would be very heavy and sharp, or where the authorities object to the laying of rails on account of the damage to the roadway. Two systems are in actual use—the Siemens & Halske and the Lombard-Gérin.

The Simens & Halske experiments date back to 1882. A trial ground was established in the outskirts of Berlin, and on this was run a light carriage, the front axle of which was provided with steering gear, while the rear axle was driven by two motors hidden under the seat of the driver. Current was taken from two copper wires hung on wooden poles by the side of the roadway. Upon these wires ran a small eight-wheeled carriage which was kept from overturning by a rather heavy weight. This small carriage was drawn along after the motor vehicle by a flexible cable. More urgent affairs caused the suspension of the trials until the time when the company, in connection with M. Max Schiemann, built the new electric omnibus system which since July, 1902, has operated in the Biela valley (Figure 3). The line has an extent of 21 kilometres, extending from the bottom of the valley to the Königstein station. The speed attained is 12 kilometres an hour. Nowhere has it been necessary to make any changes in the line, except the placing of the ordinary cross arms carrying two wires, the second serving for the return. Contact is made by two trolleys, formed of light steel tubing and so flexible that the vehicle may deviate a distance of three metres either side of its normal path without their losing the wire. Steering is by the front wheels, and the omnibus has a single compartment.

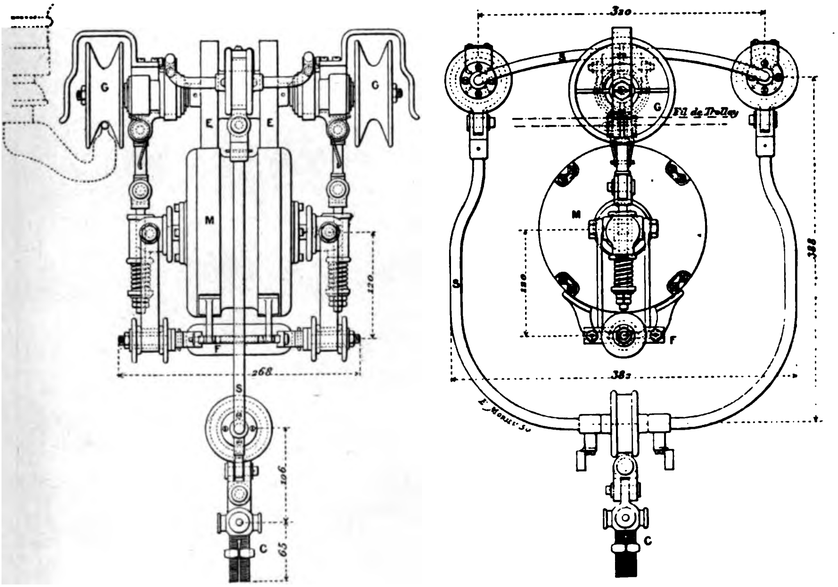


FIG. 5. THE LOMBARD-GÉRIN AUTOMOTOR TROLLEY.

It is these two latter features which distinguish these vehicles from those supplied to the Societa Alta Italia and exhibited as features of much interest at the last exposition at Turin. The Italian carriages (Figure 4) are divided into two compartments and carried on two two-wheeled bogie trucks connected by transverse straps forming the diagonals of a rectangle of which the axles are the opposite short sides. By this system all four wheels give direction to the vehicle; when it is steered aside or around a curve, the two wheels on one side approach nearer together while the two wheels on the other side spread wider apart. The arrangement is peculiarly suited for turning very sharp curves or corners.

The second solution of the difficulty of maintaining contact with the overhead wires is furnished by the Lombard-Gérin automotor-trolley system. In this, the trolley carriage is not towed by the motor vehicle; it is equipped with an electric motor and is itself automobile. A simple automatic mechanism secures synchronism of speed between the trolley and the vehicle, without any intervention on the part of the driver. The automotor trolley runs ahead, and keeps a certain tension on the flexible cable connecting it to the vehicle. This tension permits the trolley wire and cable to be maintained at a proper height above the ground on either ascending or descending grades. The length of the flexible cable is proportioned to the width of the road. It is attached to the vehicle by an easily uncoupled electric connection.

The trolley itself (Figure 6) in almost all its exposed parts is made of aluminium and does not weigh more than 20 kilogrammes, sufficient to assure its adherence to the overhead wires and to maintain proper tension of the flexible cable. The triphase motor of the trolley (M, Figure 5) is suspended between the wires and below them, by a frame resting on the shaft which carries the sheaves G, rolling on the trolley wires. The motor has a fixed field magnet while the revolving armature drives by friction the fibre wheels E, mounted on the shaft of the rolling sheaves, and thus propels the trolley carriage. Suspension screws and nuts give the proper tension. 500-volt direct current is taken from the wires by the rolling sheaves, and transmitted by two conductors, contained in the flexible cable, to a pole fixed on the top of the vehicle, and thence through the controller to the motors. A very simple device—three collector rings attached to these motors and connected to the proper points in the winding of the armature—allows three-phase current to be taken off, the motor thus serving as a converter, independently of its functions in driving the vehicle. This triphase current collected by the three rings is transmitted by three wires also enclosed in the flexible trolley cord.

The speed of a triphase motor being synchronous with the current which supplies it, it follows that the motor of the trolley revolves automatically at a speed proportional to that of the motor of the vehicle. The relation is so adjusted that the speed of advance of the automotor trolley shall always be slightly greater than that of the omnibus and thus the cable always be tense. The connection of the cable to the automotor trolley is by universal-joint suspension, so that the pull of the tension is always in the bisectrix of the two wires and never produces any torsional strain. Besides the wires already mentioned, the flexible cable contains a sixth, operating a small electro-

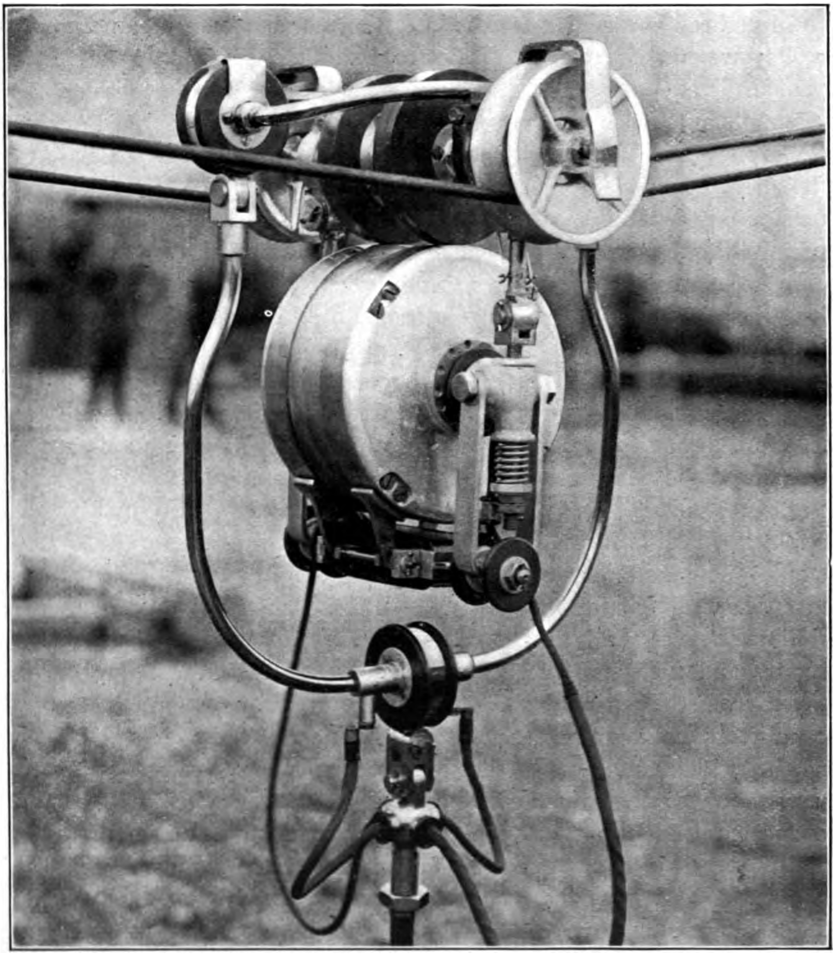


FIG. 6. LOMBARD-GÉRIN AUTOMOTOR TROLLEY.

magnetic break, F. This allows of blocking the trolley carriage on the wire in case of need, as for example if the vehicle is stopped on a hill.

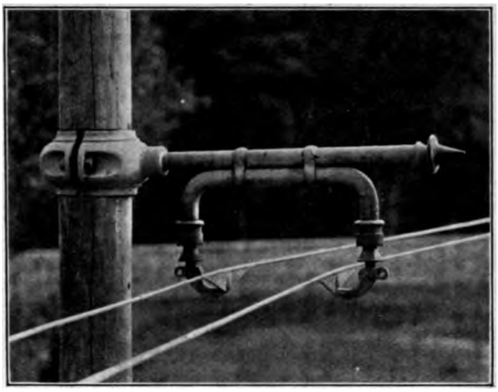


FIG. 7. TROLLEY WIRE SUSPENSION, LOMBARD-GÉRIN SYSTEM.

The trolley lines in this system are two parallel copper wires of 8 millimetres diameter, stretched 30 centimetres apart. The malleable bronze pieces supporting the wires are screwed into ambroïne (porcelain) insulators fixed upon C-shaped pieces and either fastened to brackets, where the line is at the side of the road (Figure 7), or suspended when it is in the middle of the roadway (Figure 8). The C-shaped pieces are made of iron tubing and permit the passage of the automotor trolley. The vehicle is very comfortable (Figure 9); the controller, besides speed changes, permits the stopping of the trolley by means of the break already described. A commutator also permits the direction of movement of the trolley to be reversed. The front wheels are steering wheels, the rear, driving wheels. These are separately chain driven, each by an 8-horse-power motor.

From the point of view of manœuvering, the "railless omnibus," of either system, is indisputably superior to the tramway. It can with the utmost ease avoid obstacles, pass or make way for other vehicles (Figure 10), turn, even with the rigid trolleys (Figure 11), and cross. If two omnibuses on the Lombard-Gérin system meet, they exchange trolleys (Figure 12) the operation taking about one-half minute. If the vehicles are of the Siemens & Halske type, one of them stops and lowers

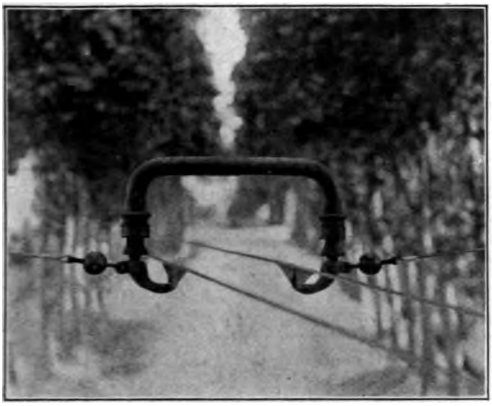


FIG. 8. TROLLEY WIRE SUSPENSION, LOMBARD-GÉRIN SYSTEM.

its trolleys and the other turns out and passes by as shown on page 48.

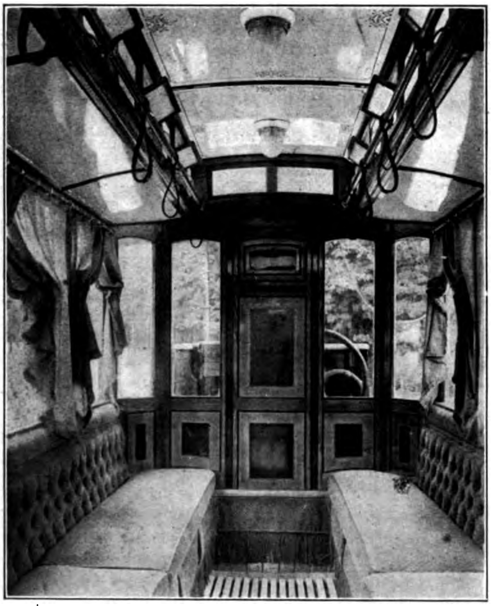
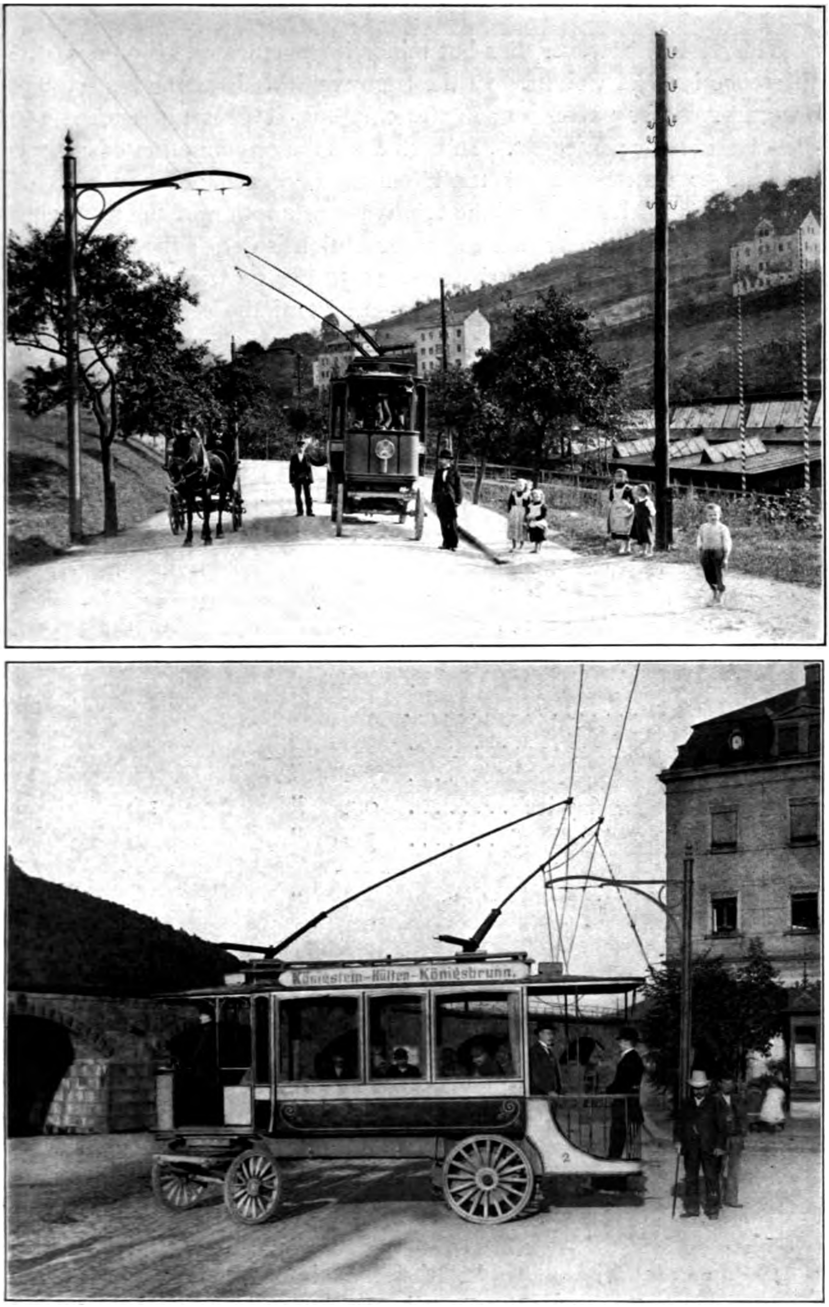


FIG. 9. INTERIOR OF LOMBARD-GÉRIN TROLLEY OMNIBUS.

To take up now the advantages claimed for the traction without rails, I may borrow from a *brochure* of the "Compagnie de Traction par Trolley Automoteur." For a tramway, the construction cost will be at least 30,000 francs per kilometre, and the gross expense 2,800 francs per kilometre per annum. These charges may or may not be justifiable, depending on the frequency of the service. On a 5-minute, 10-minute, or even a 15-minute headway, the expense per car-kilometre is relatively low; with a lower frequency of car movement it assumes serious importance and becomes prohibitory when half-hourly or hourly departures are all the traffic conditions will support. Whenever, therefore, the vehicles must be run at long intervals, the track must be dispensed with and the electric omnibus installed, the more that the rails may be installed without the loss of any useless outlay, whenever the increasing density of traffic justifies. The net cost of either service depends on the following five factors:—Cost of electric power personnel employed on the vehicles; maintenance of vehicles and car houses; maintenance of the overhead wires; administration, general expense, and sundries. The omnibus evidently has not so high a co-efficient of tractive efficiency as the tram car. The results determined for the Siemens & Halske system were:

	Omnibus (kilogrammes).	Tram Car (kilogrammes).
Weight	4,500	10,000
Starting effort	400 to 500	500
Normal requisite tractive effort		180 to 210
On good roads	270, mean	
On bad roads	500, maximum	



FIGS. 10, 11. TROLLEY OMNIBUSES TURNING OUT FOR VEHICLES AND TURNING AROUND AT THE END OF A RUN.

This factor, however, has but minor importance on account of the difference in dead weight. In the tramway, this is at the lowest 233 kilogrammes per passenger; in the omnibus, it does not exceed 159 kilogrammes per passenger. In both cases the consumption of current is about 50 watt-hours per ton-kilometre per each one per cent. of grade. Upon calculation of the relative consumption of the two types of vehicle, it will appear that the consumption is decidedly less for the omnibus, and that the economy reaches 30 per cent. on a 7 per cent. grade. On the other hand, the excess cost of the omnibus on level roads is but 1 centime per car-kilometre, an insignificant figure when compared with the expense attendant upon maintenance of way, which may be taken at 2 centimes per car-kilometre on a 5-minute headway. The wages cost and the upkeep cost of the rolling stock are substantially the same in both cases; those of repair of the overhead wire are higher with the omnibus. General and administration costs are naturally variable; they may be averaged at 5 centimes per car kilometre for tramway and 4 centimes for the omnibus. In total, the expense per car-kilometre, not including that from the maintenance of way or the interest and amortisation on its cost, may be thus summarised:

	Tramway.		Omnibus.	
Electric power	8.4	centimes	9.5	centimes
Wages on vehicles	9.0	"	9.0	"
Upkeep of vehicles and sheds	5.0	"	5.0	"
Repairs of overhead wire	0.5	"	1.0	"
Administration and general	5.0	"	4.0	"
Total (Track costs excluded)	27.9	"	28.5	"

To take a concrete example of the possible benefits of the omnibus system, let us suppose a line of 5 kilometres length with an hourly service. For an electric tramway, the initial cost of installation would be 240,000 francs; for an omnibus line, 100,000. The working expenses of the tramway would be 12,750 francs per annum; for the omnibus line, 9,000 francs. Assuming gross receipts of 16,000 francs, the tramway would have a net earnings of 3,250 francs—1.3 per cent. on its capital; the omnibus enterprise, net earnings of 7,000 francs—7 per cent. on its capital, or five times as high a rate of dividend as the tramway.

It is apparent without explanation that the trolley vehicle running on the ordinary road may be used in goods transport as well as for passengers. A demonstration of this by the Lombard-Gérin system was made by a waggon which ran for some time from Porta Pia to Rome, and also on the line between Chillon and Lake Geneva. On the Biela valley line, operating under the Schiemann-Siemens & Halske system, also, goods were carried in a small two-wheeled truck coupled behind the omnibus, for the carriage of luggage and packages. The trials have worked well and larger waggons are planned. The Biela line is not destined merely for the transport of passengers. It is assured of an important goods traffic, principally between the saw-mills and paper mills at one end of the line and the goods station of Königstein, at the other end.

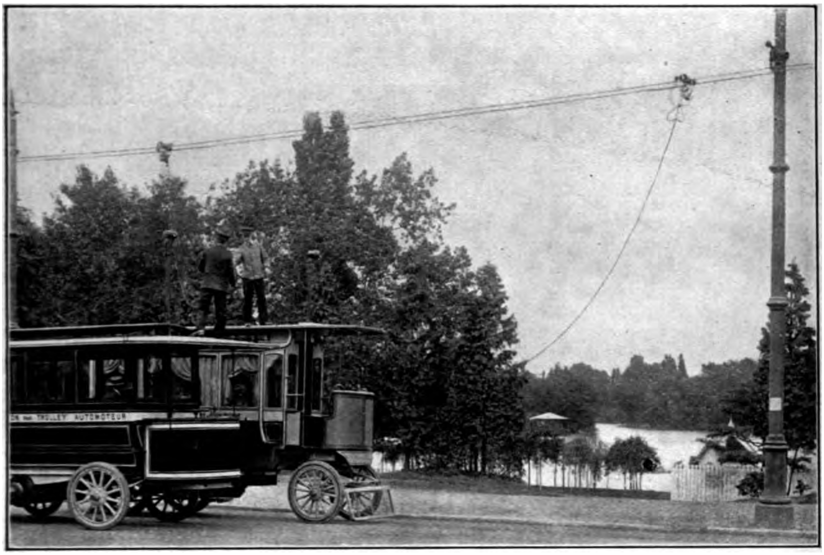


FIG. 12. TROLLEY OMNIBUSES, LOMBARD-GÉRIN SYSTEM, EXCHANGING AUTOMOTOR TROLLEYS AT A MEETING POINT.

The Schiemann-Siemens & Halske system is in use also at Grevenbrück in Westphalia, where it was recently installed for the transport of limestone from the quarries to the railway. Each truck carries 5 tons, two trucks and a locomotive constituting an ordinary train. The locomotive is provided with two 25-horse-power motives; the total weight of a train is 20 tons, of which 10 tons is dead. Under favourable conditions four waggons may be taken in one train, making a total of 34 tons, of which 14 is dead load. Current is supplied from a neighbouring station. The speed is about four miles an hour. The current consumed is about 15 to 20 amperes at 550 volts for the empty train and 30 amperes for the full load. This is an interesting example of the transport of fairly heavy loads over common roads by electric

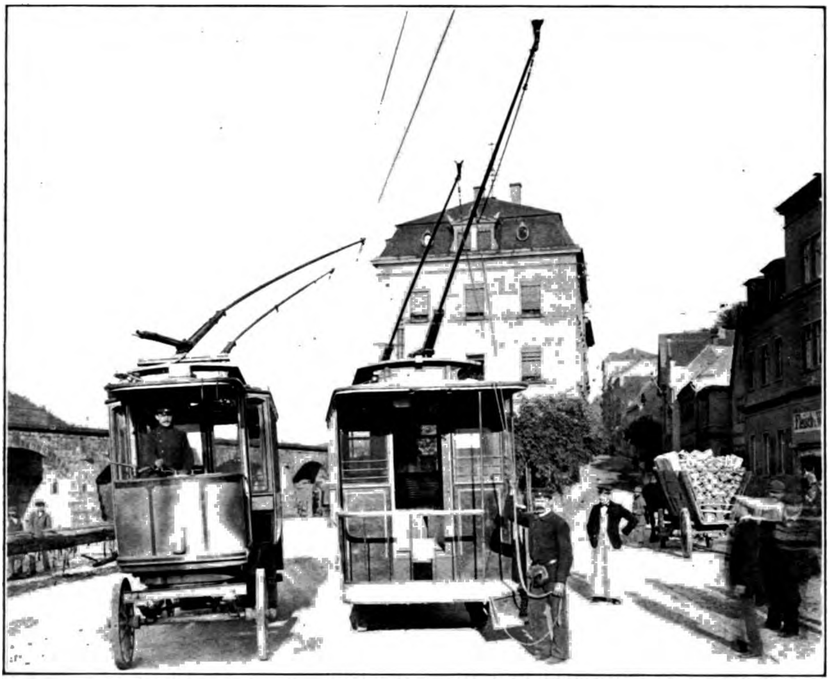


FIG. 13. TROLLEY OMNIBUSES, SIEMENS & HALSKE SYSTEM, TURNING OUT AND PASSING.

power. It is a new industry, of which we may have seen but the dawn; we may expect ere long to see its wide extension.

The short consideration we have been able to devote to the subject indicates, it seems to me, that electric traction by trolley and without rails presents great advantages over the use of accumulators, and in certain cases over that by trolley but upon rails. The problem is always complex, and no general solution is possible. Each case requires careful study to determine the bearing of the respective advantages and disadvantages. Electric traction by the overhead-trolley system, but upon the ordinary road surface, is at least in my opinion the sovereign method wherever the laying of rails is not practicable—but only pending the invention of the ideal storage battery. Then it will be the accumulator that will furnish the solution for the problems of traction in general and of electric traction in particular. No disturbance of the roadway, no *liaison* with the distant central station, no injury anywhere to the aesthetic.

RECENT DEVELOPMENTS OF THE STEAM TURBINE.

By A. Rateau.

As at present developed the steam turbine represents the work of many minds, from the aeolipile of Hero of Alexandria down to the most recently constructed machines. In the course of the growth which has converted the device from an interesting toy into a machine equalling, and in many respects surpassing, the reciprocating steam engine, M. Rateau has done much to assist in this remarkable progress, and he stands today as one of the notable figures in this department of steam engineering. A successful rotary steam engine has long been sought, and the solution of the problem has been deemed impossible by many able engineers, but in the steam turbine the question appears to have been solved, and in this solution M. Rateau has given material aid.—The Editors.

FOR several years the steam turbine has made a rapid industrial development, receiving numerous improvements which have placed it in a position to enter into an effective competition with steam engines of the reciprocating piston type, so that the turbine may confidently be expected to replace the ordinary forms of steam engine in many applications.

At the present time the results which have been obtained with the steam turbine are sufficiently high, from an economical point of view, to render them comparable with the best examples of triple-expansion reciprocating engines. For certain applications, indeed, the turbine possesses notable points of superiority over the piston type of engine, including all the inherent advantages of engines of continuous high rotative speed, such motors enabling a material reduction in the dimensions of the dynamos, alternators, fans, or centrifugal pumps to which they may be connected. In addition to this point it is hardly necessary to mention the well-known advantages included in economy of space, simplicity of construction, ease of operation, small consumption of lubricant, etc., etc.

Steam turbines form a portion of the class of machines to which the name of "turbo-machines" has been given, there being grouped under this title all the various machines which act upon fluids by means of one or more enclosed revolving wheels. In this class are included turbines and similar water-wheels, atmospheric turbines and windmills, centrifugal and helicoidal fan blowers, centrifugal and helicoidal pumps, steam turbines, and propelling screws for boats and for aeronautical machines.

A steam turbine consists essentially of a distributing portion or portions, so arranged as to direct the steam obliquely against the revolving wheel, and of a wheel, or number of wheels, to receive the impulses of the jets of steam.

According as the path of the fluid remains at a constant distance from the axis of rotation, or is directed in a plane perpendicular to the axis, we have an axial or a radial turbine. Radial turbines are centrifugal if the fluid moves away from the axis, or centripetal if it moves towards the axis. At the present time almost all the turbines in use are of the axial type, since this form presents much greater facility for construction than the radial types.

Considered from the point of view of the action of the steam, we may consider: turbines of *action* (impulse turbines), and turbines of *reaction.* The first class, or impulse turbines, are characterised by the fact that for each group, consisting of a distributor and its corresponding revolving wheel, the steam is expanded entirely in the distributor, acting upon the wheel by virtue of the velocity which it has thus acquired. In the case of the reaction turbines, on the contrary, the expansion is only commenced in the distributor, and is completed in the revolving wheel. These two modes of action of the steam include interesting practical consequences.

In the first place, in a reaction turbine each wheel is subjected to different pressures upon its two faces; hence there results a longitudinal thrust which it is necessary to resist by the employment of balancing pistons. This difference in pressure tends to cause leakages of steam by reason of the clearance and play which exists between the fixed and the moving parts; hence it becomes necessary to reduce this clearance to a minimum, thus introducing certain difficulties in construction. This inconvenience does not exist in the case of the impulse turbine, and hence no balancing pistons are necessary, and a greater clearance may be permitted between the fixed and the moving parts.

The motor couple produced by the discharge of a fluid current upon the revolving wheel of a turbine may be calculated, as shown by the writer in his treatise on "Turbo-Machines," *(Revue de Mécanique—July, 1897)* by the formula:

$$C = \frac{1}{g} (r_0 a_0 - r_2 a_1)$$

in which:

I = the weight of fluid discharged through the wheel.

r_0, and r_2 = radii at the points of entrance and discharge,

a_0, and a_1 = the projections of the velocities of the fluid upon entering and upon leaving the wheel upon the velocity of its motion.

We shall not here discuss further the details of the theory, as it requires an extensive development for proper treatment, but proceed rather to a description of the actual operative types of the steam turbine, with some of the more important results which have been obtained. In order to simplify this examination we shall divide the machines in practical use at the present time into two classes, according as the rotating member is composed of one or of several wheels.

The first class, employing but a single wheel, contains two machines, the turbine of de Laval, and the machine of the Pelton type, designed by the writer.

The de Laval turbine is sufficiently well-known at the present time to require no detailed description. It is a pure impulse wheel, the buckets, numbering about two hundred, being fixed in the rim of a steel disc, this latter being made in the form of a solid of revolution of uniform resistance. The distributor consists of lateral nozzles, variable in number, and capable of being closed independently of each other. This turbine, like others containing but a single wheel, attains very high rotative speeds, necessitating the use of reduction gearing in the transmission. This is one cause of reduction in the efficiency, to which must be added the loss due to the fact that the steam, at the moment when it strikes the buckets, has a velocity about four times the peripheral velocity of the wheel, even when the latter is revolving at the maximum speed permitted by the resistance of its materials; while, for the maximum efficiency, the peripheral velocity should be a little less than one-half that of the steam.

In the single-wheel turbine designed by the writer the disc is made of a special piece of forged steel. The buckets, instead of being attached to the rim of the disc, are milled out of the solid metal of the rim, their form being that of the Greek letter omega, formed of two circular arcs, as shown in Figure 1. The buckets are short and thick, and consequently are of great strength, so that up to the present time there has been no instance of rupture. The steam is directed against the wheel by suitable jets, and being divided by the central fins, is discharged in two currents into lateral exhaust passages from which it escapes by a single exhaust pipe. The discharge of steam through the nozzle is regulated by a needle valve, controlled by a wheel and screw.

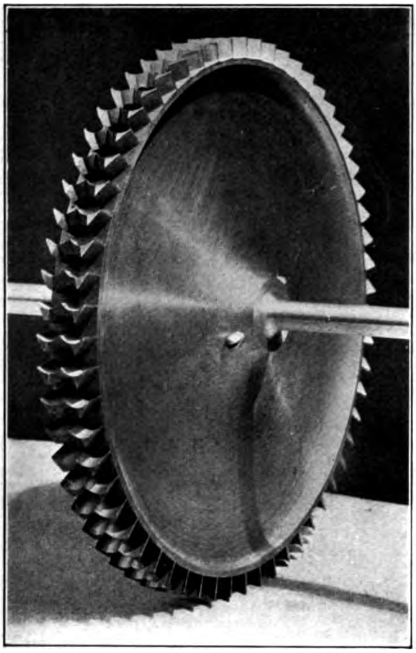


FIG. I. RATEAU SINGLE-WHEEL TURBINE.

The rotative speeds of this turbine are necessarily very high, so that it becomes necessary to employ speed-reduction gearing; double spiral gears are used, similar to those found in the de Laval turbine, and in conformity with the suggestion of the writer in a communication to the *Société de l'Industrie Minérale à Saint Etienne,* in 1890.

The efficiency of these turbines, although fairly satisfactory, is distinctly inferior to that of turbines of the multiple-wheel type, of which we shall now proceed to speak. Among the multiple-wheel turbines we shall mention the Parsons turbine, the Curtis turbine, and the Rateau turbine.

The Parsons turbine has been the subject of numerous articles and its general construction is so well-known that it is hardly necessary to describe it anew. It belongs to the reaction system, and is the practical realisation, with the perfecting of many interesting details, of the idea set forth by the French engineer Tournaire, as long ago as 1853.*

As this is a reaction turbine there exists a longitudinal thrust which it is necessary to oppose by compensating pistons, and in order to avoid injurious losses from leakage, the clearance spaces between the fixed and moving portions must be reduced to an extremely small amount, this involving a high degree of precision in the construction.

The Curtis turbine, an American invention, has recently been described in the technical journals; it belongs to the impulse class, and is peculiar in having a vertical axis.

The Rateau multicellular turbine, the result of an especial study of the subject by the writer, was briefly described in 1900, in a report presented by him upon the subject of steam turbines at the International Congress of Applied Mechanics at Paris in July 1900. In de-

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* Comptes Rendus de l'Academie des Sciences, 28 Mars, 1853. Dictionnaire des Arts et Manufactures de Laboulaye, 1877.

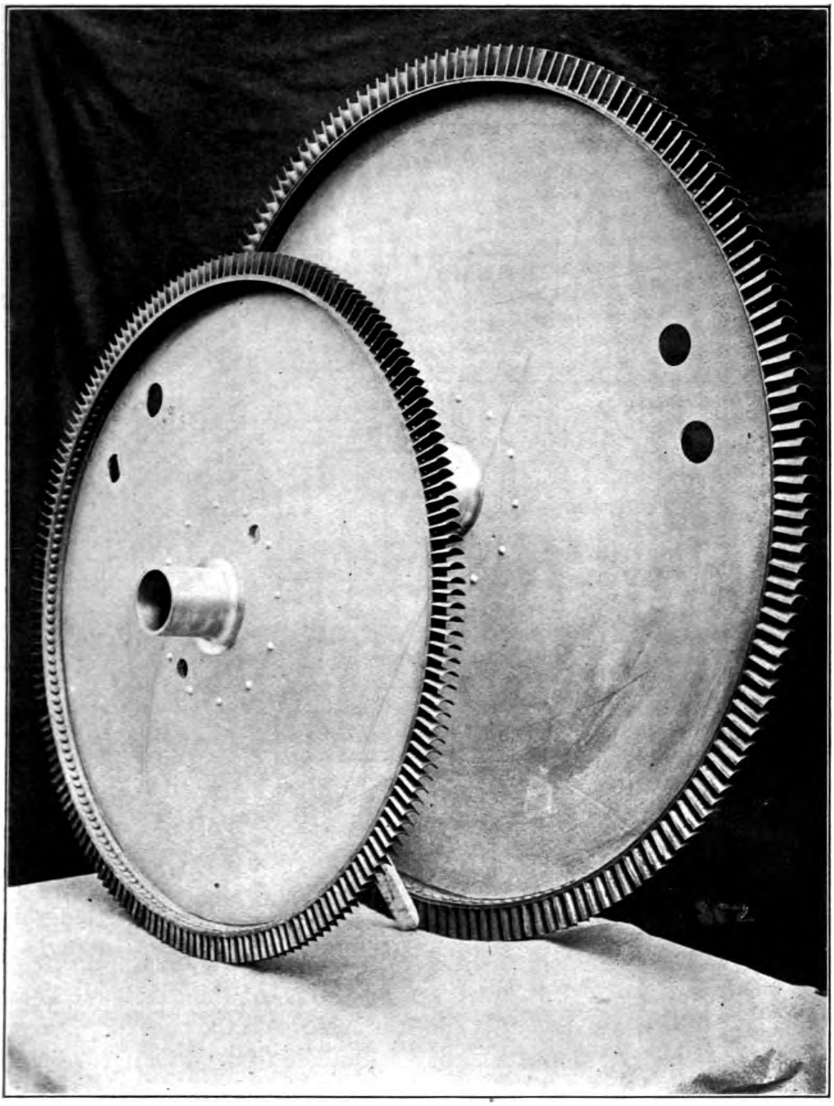

FIG. 2. REVOLVING WHEELS OF RATEAU MULTICELLULAR TURBINE.

signing this machine it was sought to satisfy the following conditions:

1. The attainment of a high mechanical efficiency, together with as low an angular velocity as possible;
2. The provision of a large, and at the same time non-injurious clearance between the fixed and the moving parts:
3. The attainment of the least possible weight of the whole machine, and especially of the rotating parts.

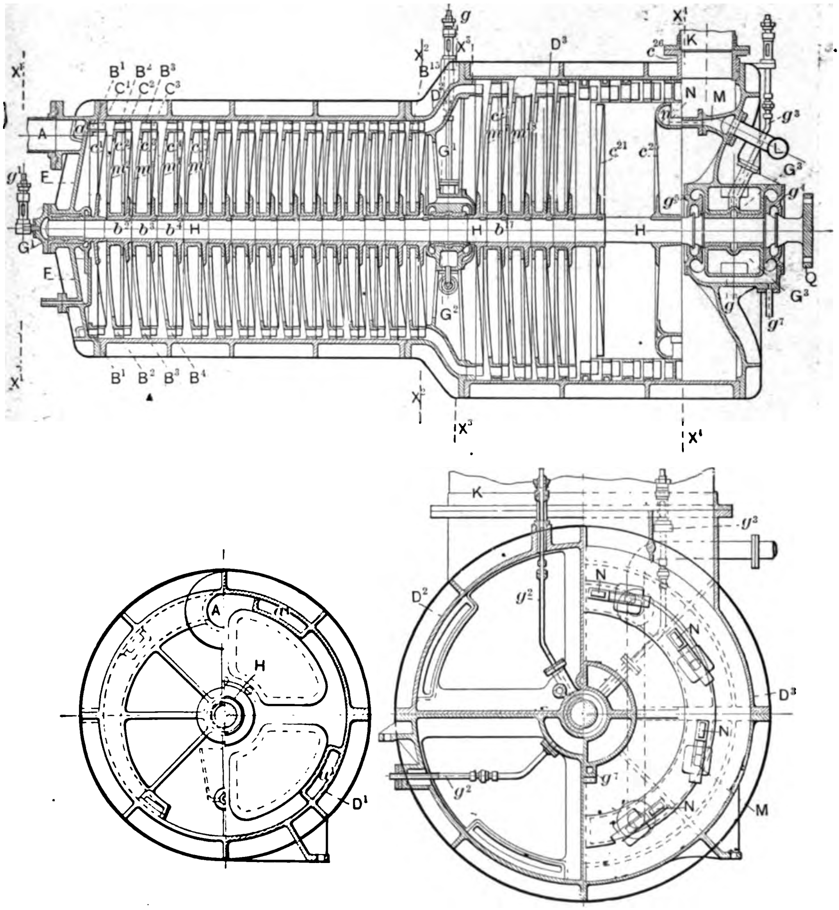

FIG. 3. THE RATEAU MULTICELLULAR STEAM TURBINE.

The revolving wheels are formed of discs of thin sheet steel, as shown in Figure 2, carrying cylindrical buckets on the periphery, these buckets being rivetted to a band of steel welded to the disc. This gives a very light and strong construction, maintaining its balance at all speeds. The guide buckets are fixed in circular diaphragms, secured at the periphery in grooves cut in the interior of the turbine case. There is thus left between the successive diaphragms a series of annular chambers in which the revolving wheels are placed, Figure 3. The shaft passes through bushings fitted in the diaphragms, there being but little play or clearance. Between the fixed and revolving portions of the turbine, however, the clearance may readily be made as much as 5 or 6 millimetres, without injury. The main bearings of the shaft are generally outside of the casing, a special form of stuffing box being employed, assuring tightness against leakage. The external appearance of the machine is shown in Figure 4.

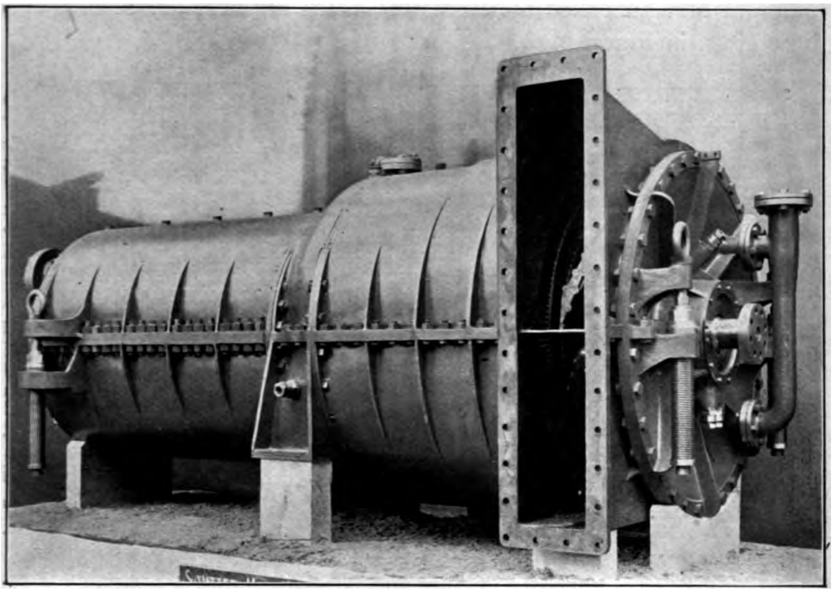

FIG. 4. EXTERNAL VIEW OF THE MULTICELLULAR TURBINE.

An ordinary compensated centrifugal governor is used to regulate the speed, acting by varying the pressure of the steam delivered to the turbine. By means of a by-pass in the main steam pipe it is possible to deliver steam of full pressure both to the entrance of the turbine and to a point in the machine nearer to the condenser, this enabling a higher power than the normal amount to be produced by the machine, much in the same manner as a compound engine may be used with full pressure steam in both high and low-pressure cylinders.

I shall now proceed to justify my statements in regard to the efficiency of the steam turbine by giving some data and results of actual tests. It will be understood that the efficiency will be computed by taking the ratio between the theoretical consumption of an assumed perfect engine and the actual consumption of the engine under consideration; both being referred to the net power delivered at the engine shaft, or better, to the electrical power at the terminals of the generator, when a generating set is under consideration. The theoretical consumption will be taken as that which corresponds to the maximum amount of work of which the steam is capable at the condition (saturated or superheated) in which it is delivered to the engine, expanding from the higher to the lower pressure adiabatically and without loss. The laborious calculations which would otherwise be necessary in making this computation may be dispensed with by using the diagram first published by the writer in the *Annales des Mines,* and here given in Figure 5.

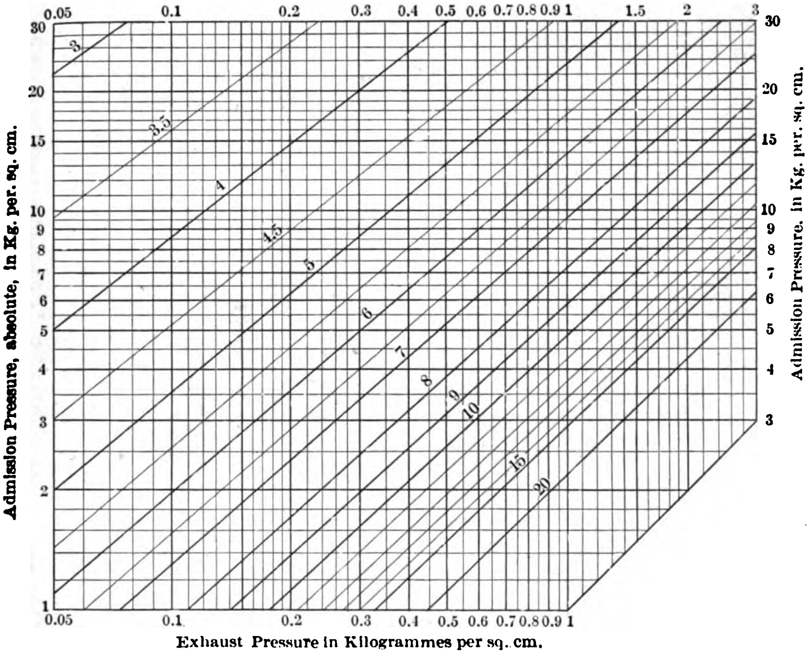

FIG. 5. DIAGRAM FOR COMPUTING THEORETICAL STEAM CONSUMPTION.

One of the most important trials which has been made of the Parsons' turbine is that upon the machine at Elberfeld, this being a generating set of 1,200 kilowatts, tested by Messrs. Lindley, Weber and Schröter. The following table is taken from their report:

Test of Parsons' Turbine at Elberfeld.	Metric units.	British units.
Initial pressure, mean*......................	7.81 kg. $cm.^2$	110 lb. sq. in.
Exhaust pressure	0.063 "	8 " "
Superheat	21° C.	38° F.
Load on generator	1,190 kw.	
Revolutions per minute	1,480	
Steam consumption per k.w. hour observed...	8.81 kg.	19.5 lb.
Steam consumption, theoretical, incl. superheat	5.05 kg.	11.2 "
Efficiency of generating set	0.573	

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* The mean initial pressure was the average of the extreme values of the oscillations produced by the action of the admission valve.

I will now give the data and results of a test of a Rateau turbine of 500 horse power, forming a portion of a group of three machines driving continuous-current dynamos at the central station of the Peñarroya mines in Spain, and constructed by MM. Sautter, Harlé & Cie., of Paris.

TEST OF RATEAU TURBINE AT PEÑARROYA.

Data.	¼ Load.	½ Load.	Full load.	Overload.	Overload at 2,400 rev.
Electrical h. p. at brushes	135	259	525	627	641
Admission presence, absolute, kg. per cm.^{2}	3.25	5.4	9.6	11.00	11.0
Exhaust pressure, absolute, kg. per cm.^{2}.	0.0877	0.094	0.115	0.128	0.128
Theoretical steam consumption of perfect engine per h. p. hour.............	4.95	4.43	4.00	3.95	3.95
Actual steam consumption per electrical h. p. hour, at brushes..............	9.66	8.16	7.14	6.95	6.74
Global efficiency of the electrical generating set	0.513	0.540	0.560	0.569	0.580

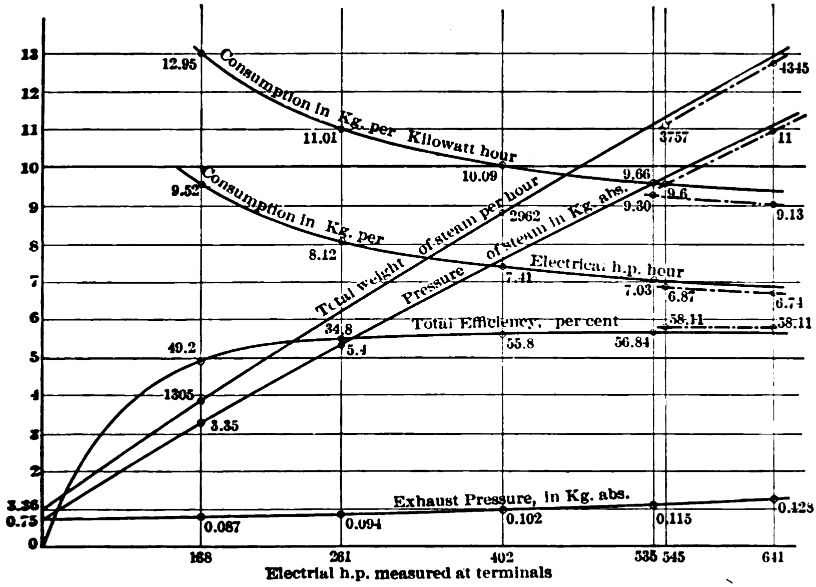


FIG. 6. CURVES SHOWING PRESSURES AND PERFORMANCES OF A 500 H. P. GENERATING SET, RUNNING AT 2,400 REV. PER MIN.

It will be seen from this table that the steam consumption per electrical horse-power hour fell as low as 6.74 kilogrammes, or 14.9 pounds, a very low figure for a machine of this size. The "global" efficiency, that is to say, the combined efficiency of the turbine and the

TEST OF RATEAU TURBINE AT THE BRUAY MINES.

Rev. n	Volts. V	Amp. A	K.W. at terminals.	Elec. H. P. at terminals.	Absolute Pressures		Temp. of steam. t	Vol. of steam measured	Steam Consumption		Global Efficiency.*
					Admission.	Exhaust.			Measured K	Theoretical K	
1600	495	385	190.5	259	0.845	0.150	132	4600	18.0	10.05	0.559
1830	503	392	197.5	268.5	0.845	0.150	132	4600	17.4	10.05	0.578
1840	503	393	198	269	0.845	0.150	133	4600	17.3	10.05	0.581
1605	500	465	232.5	316	1.01	0.177	135	5700	18.05	9.05	0.544
1700	510	472	240.5	327	1.01	0.181	135	5700	17.45	9.75	0.559
1800	515	480	247	336	1.01	0.184	135	5700	16.95	9.85	0.580
1610	Running empty	not excited.			0.130	0.087	111.0				0
1600	500.7	278.1	140.0	191.7	0.650	0.128	135	3663	19.1	10.1	0.530
1591	505.0	399.6	202	275	0.902	0.103	137	5010	18.0	9.50	0.531
1598	503.2	462.1	232.5	316.5	1.034	0.100	117	5730	17.0	9.94	0.550

During the above trials the barometric pressure was 755 mm. for the first 6 tests, 760.5 mm. for the 2 following, and 759 mm. for the last two.

* The "global" efficiency corresponds to the ratio of the electric energy, measured at the terminals of the dynamo, to the energy theoretically contained in the flow of steam received: this efficiency being determined after deducting all the losses due both to the turbine and the dynamo.

dynamo, reaches 59 per cent. The diagram, Figure 6., shows the variation in steam consumption per electrical horse power and per kilowatt, and that of the global efficiency of the turbine-dynamo as a function of the power developed. Upon examining this diagram one is struck immediately with a peculiar feature. The curve representing the steam consumption is practically a straight line, the ordinate at the origin being very small, showing that the steam consumption is almost exactly proportional to the power developed, except for very light loads. The steam consumption when running without load, the dynamo being excited, is about 10 per cent. of that at full load. For a reciprocating engine, under the same conditions, the steam consumption when running without load and with the dynamo excited, is from 15 to 25 per cent. of the consumption at full load.

A number of machines of this type have been built and others are under construction. Referring to some of the more important ones, we may mention: a turbo-alternator of 1,000 horse power, installed in the works of MM. Sautter-Harlé & Co., at Paris; a turbo-dynamo set of 540 horse power at the Huta-Bankowa Iron Works, Russia; a turbo-alternator of 400 horse power for the Société Electrique de la Loire; a turbine-dynamo of 600 horse power for the Ateliers de Rüschlikon, Switzerland, and two of 1,500 horse power, one for the power plant at La Goule, Jura, Switzerland, and the other for the works at Rheinfelden, Baden, these last three machines having been constructed by the Oerlikon Works, near Zürich.

The table on page 58 gives data and results of trials made of a low-pressure turbine of 300 horse power at the Bruay mines, Pas de Calais.

The interesting feature about these figures is the manner in which they show the very economical use of very low-pressure steam.

It will be seen that the efficiency is even slightly higher than that obtained with high-pressure steam, while in the case of reciprocating engines the results with low-pressure steam are very bad. In addition to the poor economy with low pressures, a reciprocating engine would have to be made with cylinders of very large size, thus adding difficulties in connection with first cost and with erection and space.

This interesting property of the steam turbine, permitting it to be operated to advantage with very low-pressure steam, has suggested to me a method of employing it to utilise the exhaust steam of high-pressure reciprocating engines, such as are in use in mines, rolling mills, etc. For this purpose I have designed a regenerative accumulator which converts the intermittent discharge of the exhaust steam into a continuous flow, suitable for use in the turbine. In this way the primary engine obtains all the benefit due to the use of a condenser, and an important economy is effected. This plan has been put into practical operation at the Bruay mines, the exhaust steam from one of the winding engines being used to operate a turbine of 250 horse power. A similar, but more important installation, including two turbo-generating sets of 650 horse power, is under construction for the Reunion mines, in Spain.

In addition to the use of the steam turbine for driving electric generators, it has been found especially well adapted for operating centrifugal pumps and fan blowers. The high rotative speeds obtainable render it practicable to construct pumps of large capacity and to make fan blowers capable of producing much higher pressures than have heretofore been possible with such apparatus.

Thus, for example, a turbo-pump of the Rateau system, built by MM. Sautter-Harlé & Cie., in which the pump wheel is only 8 centimetres in diameter, delivers 12 litres per second to a height of 263 metres, making 18,000 revolutions per minute, and giving a mechanical efficiency of about 60 per cent. Another arrangement is that of the multicellular centrifugal pump, which permits the elevation of a continuous stream of water to a great height, while employing much lower rotative speeds than the preceding, and having an efficiency altogether comparable to that of a piston pump. An example of a pump of this kind is seen in Figure 7, which represents a multicellular centrifugal pump and turbine in operation at the Falkenau mines in Bohemia, elevating 3 cubic metres of water per minute to a height of 212 metres, operating at 3,200 revolutions per minute. The steam consumption of this set is 12.5 kilogrammes per horse power, based on the effective work delivered in the quantity of water elevated. The steam pressure at admission is 7.30 kilogrammes per square centimetre (absolute) and the exhaust, 0.174 kilogrammes. With a better vacuum, which might readily be obtained, this performance would be improved. The total efficiency of pump and turbine is 36 per cent., which corresponds to an efficiency of about 65 per cent. for the pump and 54 per cent. for the turbine. There is under construction at the works of MM. Sautter-Harlé & Cie., a multicellular turbo-pump for the Bruay mines to elevate a continuous jet of 250 cubic metres per hour to a height of 360 metres, corresponding to a net effective work of 335 horse power. The guaranteed steam consumption, including the resistance of the air pump, is only 10.5 kilogrammes.

Turbo-fans are comparable in all points to turbo-pumps. Even with a single wheel very good results have been obtained, giving pres-

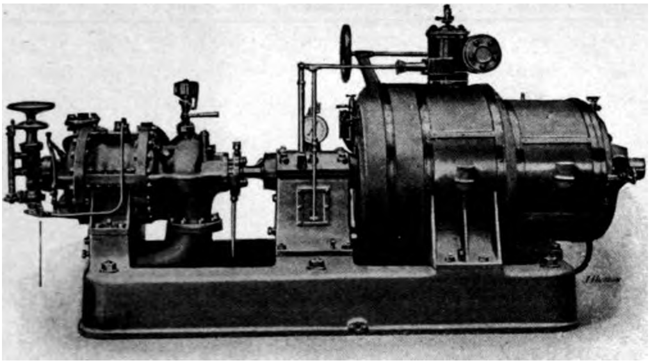


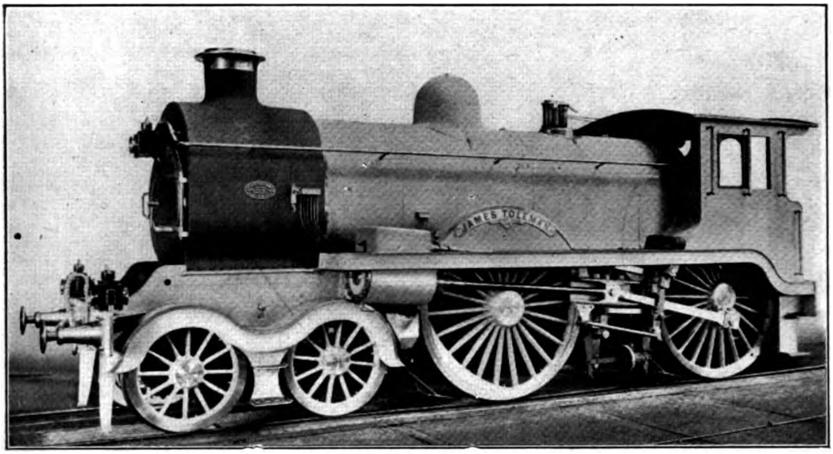
FIG. 7. MULTICELLULAR CENTRIFUGAL TURBO-PUMP.

sures up to 6 metres of water. A turbo-fan in which the wheel is only 25 centimetres in diameter, running at 20,000 revolutions per minute, has delivered 0.7 cubic metre of air per second at a pressure of 5.50 metres of water, with a mechanical efficiency of about 60 per cent. MM. Sautter-Harlé & Cie. have constructed a turbo-blower for blast furnace service, for the Chatillon-Commentry Works, which, with a wheel of 30 centimetres in diameter, delivers 2.5 cubic metres of air per second at a pressure of 2.50 metres of water. Similar blowers have been made for the French navy and for the British Admiralty.

Turbo-compressors of the multicellular type possess material advantages over the ordinary piston type, especially with regard to the small space required for the installation of a machine of large capacity. In general, this is one of the most important advantages of the steam turbine and of all its numerous applications.

The brilliant applications of the turbine to navigation which have been made by the Hon. C. A. Parsons are well-known. The first trials, made in 1894 with the Turbinia, showed the possibilities of the system, and since that time a number of turbine propelled boats have been constructed, including the torpedo destroyers Viper, Cobra and Velox, the passenger steamers King Edward and Queen Alexandria, the yachts Tarantula, Lorena, Emerald, and others. The writer has also made plans for turbine machinery for two torpedo boats for the Fench navy, but owing to delays which have no connection with the machinery, these have not yet been put into service.

The future of the steam turbine now seems to be fully assured, and the day appears to be approaching when it will supersede the older type of reciprocating engine, at least for a great portion of its applications.



The "James Toleman"—Winby's Express Engine with Specially Designed Boiler.

SPECIAL FEATURES IN THE DESIGN OF LOCOMOTIVE BOILERS AND FIREBOXES.

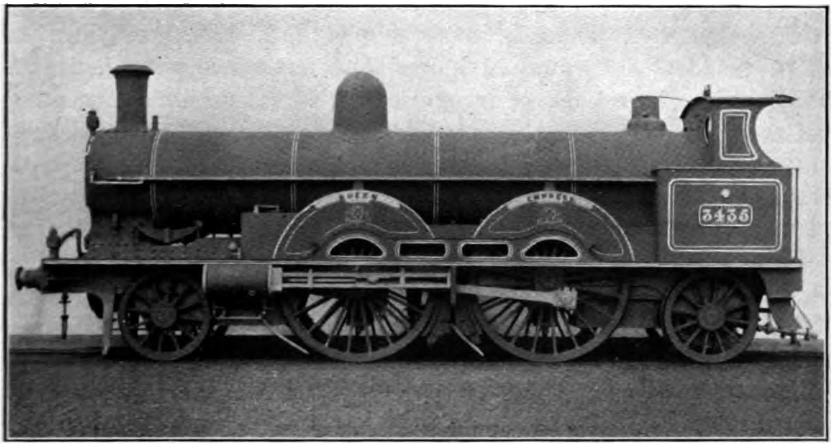
By Chas. S. Lake.

Locomotive boiler practice shows, in most advanced and striking manner, the results of the tendency apparent everywhere in steam engineering—the rising demand for increased steaming power within very limited space and dimensions. This gives a broad scope of application and interest to the discussion which Mr. Lake opens in this number and will continue in November and December. And the first two sections dealing with British types are of especial importance because the limits of the loading gauge there have forced designers to the utmost of ingenuity and effort to attain the necessary ends.—The Editors.

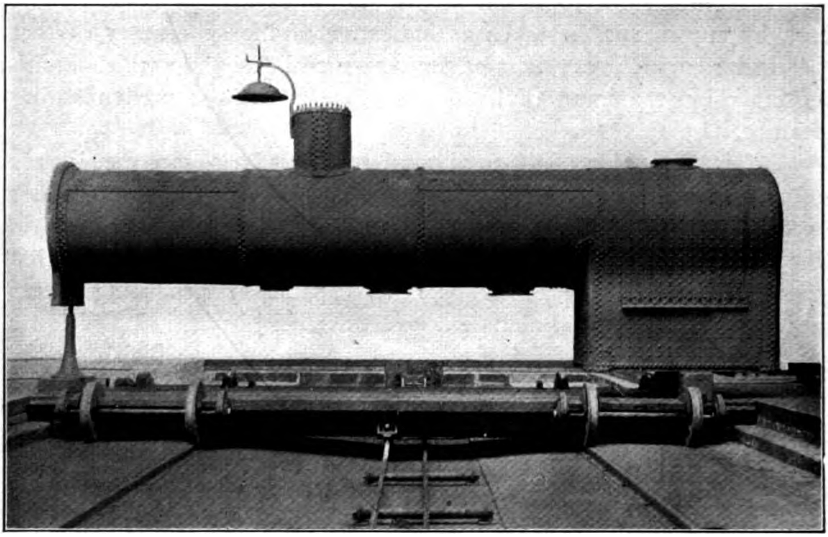
ONE of the most important considerations which the locomotive engineers of the present day have to take into account, is that of providing the engines which they design with boilers capable of generating and maintaining a sufficient supply of steam to meet all probable requirements and possible emergencies which may arise under the varying conditions which attend the everyday working of heavy and fast traffic, such as is to be found upon all the larger and more important railway systems of the world.

The tendency which is prevalent nowadays to increase cylinder proportions continually in order that greater power may be obtained, has rendered the employment of large boilers and fireboxes (containing all the heating surface area which it is possible to confine within the available limits) absolutely indispensable if ultimate success is to be ensured; but the bare fact that a locomotive is possessed of what appears at first sight to be an ample allowance in this respect must not, by any means, be taken as indicative of the superiority of that particular engine over others of similar general design, in which an imposingly large amount of heating surface is not the predominating feature.

A fair proportion of the total number of tubular square feet is very often only *nominally* of value for the purpose of rapidly evaporating water; indeed, one eminent engineer has gone so far as to say that—in his opinion—it is only for the first foot or so from the firebox end that the tubes may be reckoned upon as capable of producing steam at high pressure and in abundant quantities, and beyond that distance they are more or less inadequate for the purpose for which they are intended. This view, although it will not perhaps be generally endorsed by engineers as a body, is in itself substantially correct. It is, beyond question, an established fact that one of the chief reasons why boilers with elongated barrels are not more frequently resorted to as a means of securing a greater amount of heating surface is, that the added length of the tubes does not result in any material gain in so far as *effective* area is concerned, but merely represents on paper that which is not fulfilled under actual working conditions. The American expedient of coned boilers has recently been introduced on the Great Western Railway of England. The plan has unquestionable advantages, as it provides additional cubic space for steam-raising purposes in the immediate vicinity of the firebox. The statement which has appeared elsewhere to the effect that by means of the coned ring a larger



THE "QUEEN EMPRESS," 3-CYLINDER COMPOUND EXPRESS LOCOMOTIVE.
F. W. Webb's system, fitted with combustion-chamber boiler.



BOILER OF "GREATER BRITAIN" CLASS OF LOCOMOTIVES, LONDON & NORTHWESTERN RAILWAY.

F. W. Webb's system, 3-cylinder compound.

amount of *heating-surface* area is obtained is manifestly an absurd one. No increase in the number of tubes or their diameter is rendered possible by the use of the coned pattern boiler, therefore the augmented heating surface claimed by one writer on the subject is wholly an imaginary one.

When Mr. Webb was introducing his "Greater Britain" class of three-cylinder compound locomotives upon the L. & N. W. Railway in 1891, he adopted the unusual figures of 18 feet 6 inches for the length of the boiler barrel, but he recognised the fact that only a percentage of the total span of the tubes would be operatively efficient for heating purposes, and he consequently divided them into two groups separated by a combustion chamber, which arrangement is illustrated by Figures 2 and 3 and will be described later.

In 1895 Mr. Aspinall, the then locomotive superintendent of the Lancashire and Yorkshire Railway, furnished the Railway Congress assembled at that time, with a report upon the subject of Express Locomotives. Commenting upon this report in a leading article the *Engineer* said:—

> "Tube surface may be augmented reasonably by adding to the length of the tubes, but although increased tube surface promotes economy of fuel by increasing the quantity of water evaporated per pound of coal, it only very slightly augments the actual efficiency of the boiler.

> "Given the same grate and fire-box in two engines, one with 1,000 feet and the other with 1,200 feet of tube surface, the steaming powers of the two boilers will be pretty much the same, but the economic efficiency of the latter will be a little greater than that of the former."

These remarks bear out the contention advanced against the employment of exceptionally long tubes.

It is only during comparatively recent years that the need for enhanced steam-producing powers in locomotive boilers has been so urgently felt as it is at the present time. As a natural outcome of railway traffic developments, a demand has sprung into existence, not only for *more* locomotives, but for individual machines capable of performing, without assistance, the work previously allotted to two engines. It is necessary to provide cylinders of 19 or even 20 inches in diameter to accomplish satisfactorily the work of hauling modern heavily weighted trains, and anyone who is in possession of even the most rudimentary knowledge of the subject will easily perceive that if the maximum advantage is to be obtained from the employment of such dimensions, it is essential that a plentiful supply of steam at a high working pressure should be continuously available.

Those who have not given much time or attention to the subject are apt to conclude that there should, after all, be no great difficulty in arranging for an adequately proportioned area of heating surface, and base their opinions upon the hypothetical understanding that all it is necessary to do is to increase the diameter of the boiler and add to its length and so, *nolens volens,* the desired object can be at once attained. It is impossible to proceed very far upon such lines as these, however, before obstacles are encountered which clearly demonstrate to the practical mind the futility of adopting such methods as a means of overcoming the difficulty.

Express locomotives are, as a rule, provided with driving wheels varying between 6 feet 6 inches and 7 feet in diameter, and the boiler must be restricted to such proportions as will allow of its barrel being placed partially *between* and not wholly *above* them, as may be done with engines having wheels of small diameter. Then, over and beyond the reason given for not utilising tubes of great length (on account of their unsuitability for providing really effective heating surface except throughout a percentage of their length), there are considerations of space to be taken into account, as it must not be forgotten that an extension of wheel base follows any material lengthening of the boiler, and the serious expense which would be involved in altering existing turntables to accommodate any new design of engine is a very powerful determining factor against such a policy being generally adopted.

All these matters are engaging the very closest attention of the responsible authorities at the present time, and it is becoming increasingly evident that the direction in which the majority of them are looking for a solution of the difficulty is that of the possibilities of introducing special steam-raising appliances and devices, rather than to the development of what may be termed the "standard" type of boiler and firebox, with which finality has nearly been reached, owing to loading-gauge limits and other considerations of a like nature. It is with a view to presenting a collective survey of the widely different methods which are being employed in various countries and by engineers of sundry nationalities that the author has prepared the present article; but before passing on to a detailed description of the particular examples which have been selected for illustrating the subject in hand, a few words upon the question of the relative merits of different metals for certain specified purposes may perhaps be of interest to the majority of the readers of these lines.

Opinions vary in a marked degree upon this branch of the subject. Practice and theory also are, as usual, found to be at variance upon some of the most vital points. Many engineers favour the use of steel for boiler plates and the outer shells of fireboxes, but an equal, if not a larger, number advocate the employment of the best Yorkshire (Low Moor) iron as being superior for the purpose. One of the foremost believers in the first-named material is Mr. F. W. Webb, who constructed steel boilers at Crewe for a number of years.

The practice of so doing is becoming more general as time goes on, and from all appearances is likely to become almost if not quite as common a feature of British, as it already is of American locomotive construction.

Steel has a much higher tensile strength than is possessed by iron, the average being 26 tons to the square inch, which, with an elongation of 25 per cent. in 8 inches, represents 18 per cent. more resistance and twice the elongation that can be claimed for the latter material. As a consequence of these advantages it is possible to use thinner plates where steel is employed than would be deemed advisable in the case of iron. Another advantage which may be mentioned is the greater amount of ductility possessed by steel of good quality, which renders it more suitable for flanging than iron.

For "inner" fireboxes however, there can be no question but that copper is the best possible material that has up to the present been tried. It is vastly superior as a conductor of heat, is better capable of withstanding any sudden strains to which it may be subjected, without sustaining injury, and is, of course, an easier metal to "work," thereby greatly facilitating manufacturing processes. On the other hand it is more expensive as to first cost, and there are times when copper in sufficient quantities and of the high standard required is not available even at what are known as "standing average" prices. As regards British practice, however, its use is almost universal for the purpose, but in some other countries—especially the United States—steel is largely employed in the construction of fireboxes.

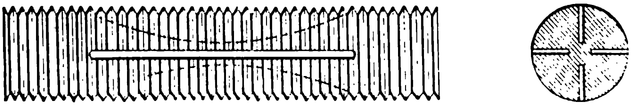


FIG. I. FLEXIBLE FIREBOX STAY.
Designed by Stone & Co.

Coming next to the question of the most suitable material for firebox stays (a most important point) we find a growing inclination to resort to bronze or copper alloys in place of copper alone. Here again the element of prime cost enters into the arguments, but I for one cannot help thinking that only copper—and that of the best obtainable quality—should be used for these stay bolts, and further, in my opinion, they should have a larger diameter than the usual 1 inch which is the average size employed. If the stay bolts were made 1½ inches in diameter and spaced at 4½ inches apart the risk of their fracturing, either in the body or in the plate, would be greatly reduced. A water space of 3 inches is very desirable, but it is difficult to arrange this under existing conditions and the usual figure is 2½ or 2¾ inches.

Hollow stay bolts are by no means uncommon upon the Continent and in the States and have met with some success. They are usually made either of copper or an admixture of that and other metals. Messrs. Stone & Co., a firm of engineers who make a specialty of these articles of manufacture, have brought out a flexible stay provided with four longitudinal slits extending for about two-thirds of its length. These slits are cut into the body of the bolt, to within about ⅛ inch of the centre, the resultant section being as shown in the illustration Figure 1. These stay bolts are said to be capable of withstanding thirty times as many strains as are those of the ordinary pattern.

With regard to the tubes, we find an equal diversity of opinion. Copper and brass undoubtedly possess some advantages over iron and steel for this purpose, but, all things considered, the extent of superiority possessed by the former metals over the latter is not very easily defined. Brass is considered by some to be the best material of all in the long run for tubes. It costs less than copper, is a very good conductor of heat, and has proved itself to be remarkably durable.

A composite material known as "red metal," consisting largely of copper, is frequently used in Great Britain and in Continental countries, as are also various combinations of copper and other metals in an alloyed state, but in America the vast majority of engineers favour iron for tubes and steel for fireboxes.

As illustrating the great difference of opinion which exists between engineers on either side of the Atlantic upon this matter a case in point may be quoted:—

During the year 1901 the American Locomotive Company built an engine at their Richmond Works for the New Zealand Government Railways, and in the course of a descriptive article upon this locomotive which appeared in the columns of one of the most important American engineering journals, the following passage occurred.

"There is, said the writer, one fad that the British and the British Colonies have hung to very persistently in engines built for them in America—that is, the firebox must be of copper and the tubes of copper or brass. In this engine the firebox is of steel, and the tubes are iron." It was also stated that the engine was built as a "sample" and was "another instance on the part of our English friends to take the pure and simple American locomotive instead of the hybrid which it was the custom to specify a few years ago." Many other extracts of a similar character could be culled from the columns of the American engineering press, and they go to emphasise the fact that American locomotive men are equally as decided in their opinion, that steel and iron are more suitable than copper or brass in the construction of fireboxes and boiler tubes, as engineers in England are in believing the opposite to be the case.

Having thus far digressed from the main topic under consideration it will be necessary, in the interests of space, to enter at once upon a discussion of the principal examples of special boilers and fireboxes which are being, or during recent years have been, tried with the object of increasing the general efficiency of the locomotives to which they have been adapted. Mr. Webb's "Greater Britain" type of boiler (to which reference has already been made) was designed at a time when the necessity for constructing some locomotives of even greater power than those already possessed by the London and North Western Railway Company at that period, was making itself felt.

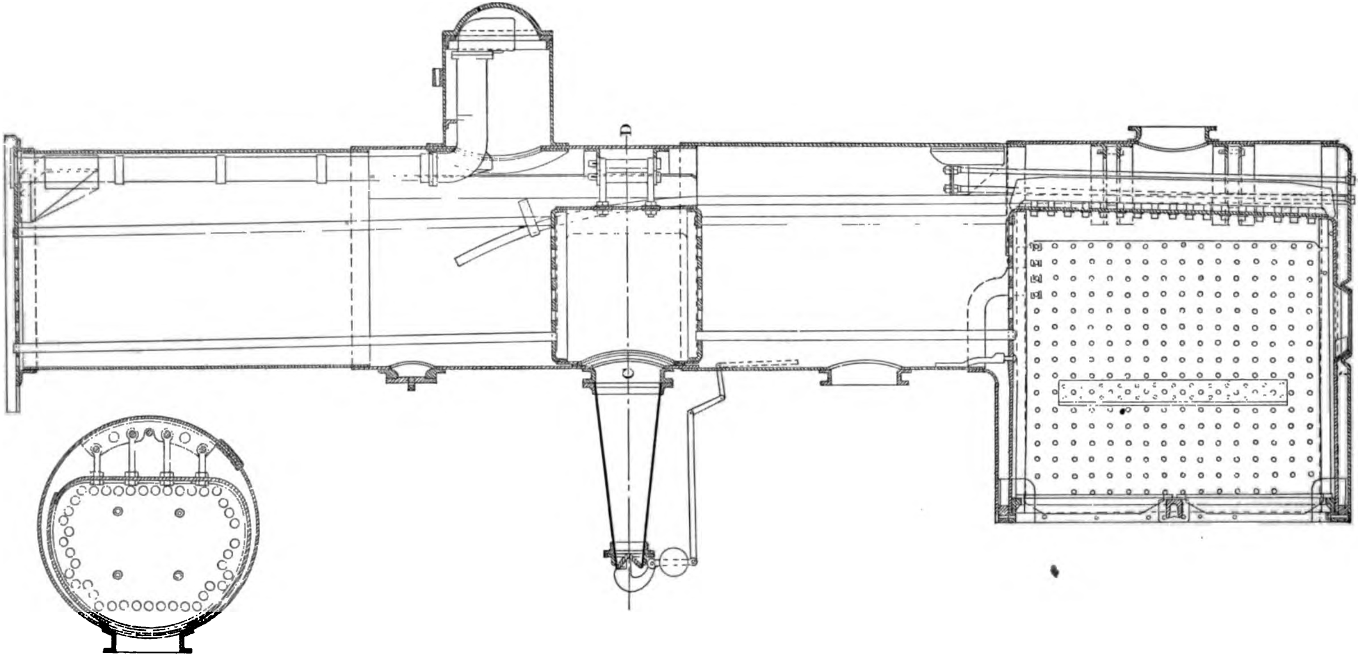
The three-cylinder compound system was adhered to and the principal dimensions of the express engines knows as the "Teutonic" class, which immediately preceded those under notice, were retained; but an additional pair of carrying wheels were placed behind the firebox and the high-pressure driving wheels were advanced so as to come immediately in front of it, thus making it necessary to adopt a much longer boiler barrel than had been used in any other engines in existence up to that time upon the London and North Western Railway.

Being of opinion that it would be of advantage if some special method of more effectively heating those portions of the tubes furthest removed from the firebox were introduced, Mr. Webb provided an intermediate combustion chamber which, as is shown in the drawing (Figure 2) is situated in such a position in the barrel of the boiler that the hopper which is attached to it is clear of the low-pressure connecting-rod end when the piston is at the end of its stroke. To the bottom of this hopper an air-tight valve is fixed and is weighted in such a manner that in its normal position it is closed, but it is connected by rods to the foot plate, in order that the driver may be enabled to open it at will for the purpose of discharging the ashes which have accumulated.

The chamber is also fitted with a steam-blast apparatus for clearing the tubes of soot.

The manner in which the combustion chamber is constructed is clearly shown by Figures 2 and 3. It will be seen, by reference to those illustrations, that the body consists of one piece of plate so fashioned as to present a flat top for the purpose of facilitating direct staying, which is effected by means of eight eye bolts, the screwed ends of which pass through the flat roof already mentioned and are secured by nuts top and bottom, whilst the other ends are connected, by four cheese-headed long bolts, to two pieces of 4½ by 8¼ by 11/16 inch angle iron placed 11 5/16 inch apart, which in turn are rivetted to the inside of the boiler shell. The course followed by the plate forming the sides and bottom of the combustion chamber is a semicircular one, joined to the flat top by means of 7¾ inch radii and coming down to within half an inch or so of the bottom of the boiler barrel. The intervening space is occupied by a foundation ring of steel for strengthening the aperture which provides communication between the chamber and the hopper, and which is sufficently large to allow of the passage of a man's body through it.

As will be seen by the cross section (Figure 3) this method of construction does away with the necessity for more than one joint, and is



Section C-D

FIGS. 2 AND 3. SECTIONS THROUGH "GREATER BRITAIN" TYPE OF BOILER WITH COMBUSTION CHAMBER.

decidedly the best and most economical plan which could be employed. The combustion-chamber tube plates are made of copper ¾ inch in thickness, flanged inwardly and rivetted to the plate which forms the body.

The tubes, 150 in number, between the firebox and the combustion chamber, are of copper, 2⅛ inch diameter outside and 6 feet over all in length. They represent 506.2 square feet of heating surface, and it will be noticed that whilst they are fixed horizontally, those which are situated between the forward tube plate of the combustion chamber and the smokebox are inclined in a downward direction towards the smokebox, the total fall amounting to 6⅜ inches in the length of 10 feet 1 inch which separates the two tube plates.

These forward tubes, of which there are also 150, are of steel and provide 875.0 square feet of heating-surface area, which together with the 506.2 square feet of the rearmost tubes, the 39.1 square feet of the combustion chamber, and 120.6 square feet which is derived from the firebox, gives a grand total of 1540.9 square feet, an unusually large allowance at the time when the engines were built.

Writing to the author upon the subject of these boilers Mr. Webb says:—

> "My reason for using steel and copper tubes in the same boiler is, that copper tubes are more easily kept tight in the firebox tube plate than steel ones, but, as there is no difficulty in keeping steel tubes tight further away from the firebox where the heat is not so great I prefer to use them in that part of the boiler between the combustion chamber and smokebox."

The company possess ten locomotives of this class and ten others of similar general design but having driving wheels 6 feet in diameter. These latter engines are known as the "John Hick" class and are used for working north of Rugby exclusively. Both series have given satisfaction, but have now been superseded by Mr. Webb's extremely powerful four-cylinder engines, in which the ordinary type of boiler with a shorter barrel has been reverted to.

No article dealing with the subject set forth in the title of the present one could be considered as even approximately complete unless it contained reference to that remarkable specimen of locomotive—and especially boiler—construction which was designed in 1893 by Mr. F. C. Winby of London with the idea of demonstrating the lines upon which, in his opinion, the locomotives of the future should be built. It will not be necessary for present purposes to enter into the merits or demerits of the design as a whole. That was done at the time of the appearance of the engine, as writers in nearly every engineering journal gave expression to more or less decided views upon the subject, some favourable and some otherwise but all voluminous in character.

Designed by an Englishman and constructed by a well-known firm of locomotive builders (Messrs., Hawthorn Leslie & Co. of Newcastle-on-Tyne) the engine was never destined to be given a trial in Great Britain but was shipped off to the States for the purposes of exhibition at the World's Fair at Chicago in 1893, where it was accorded a considerable amount of attention and criticism and was eventually tested upon the Chicago, Milwaukee and St. Paul railroad but unfortunately with only indifferent results. The principal contributory factor to this lack of success was the boiler, which as will be seen by the illustrations was of an entirely novel construction.

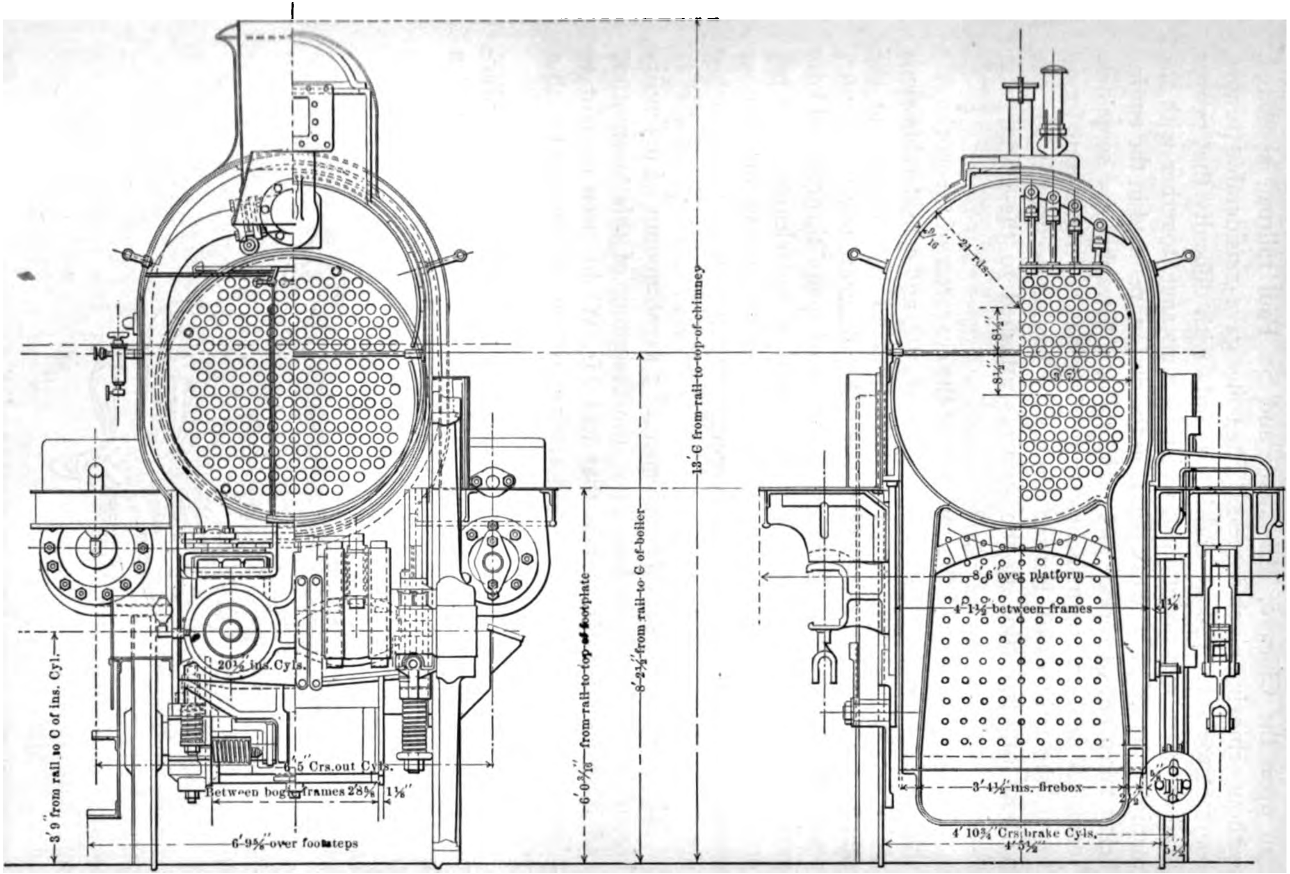
The designer aimed at providing a very large amount of heating-surface area in the tubes, and in order to accomplish this he adopted the idea of increasing them numerically as well as in length and he decided upon having 235 tubes of 2 inch diameter and 14 feet 9¼ inches in length, the resultant aggregate which he obtained from them alone being 1817.4 square feet. He found that to get a barrel of the customary cylindrical section, large enough to contain this great number of tubes, between the wheels (which were 7 feet 6 inches in diameter) would be a physical impossibility, and he therefore resolved upon utilising the unusual section shown in the cross sectional views Figures 4 and 5, which resembles as much as anything else two arches facing one another, and connected together by heavy butt straps.

A row of screw stays passing between the tubes, thus dividing them into two approximately equal groups, were used for uniting the two butt straps, these stays being pitched at very short centres with the object of providing resistance to the bursting stress which would have to be contended againt at this point.

The boiler barrel was quite moderate in length, being actually only 9 feet 2¼ inches, but the distance between the tube plates was no less than 14 feet 9¼ as stated. By referring to the longitudinal section (Figure 6) it will be seen that this was effected by means of carrying the smokebox tube plate partly into the smokebox, whilst the barrel of the boiler projected into the firebox; consequently, the grate extended beneath the boiler barrel for a length of a little over 5 feet.

The firebox was of copper, and to allow of the proper circulation of the water at its sides, slits were cut through the boiler plates where they projected into the firebox shell.

At the conclusion of the Exhibition the engine was put in steam and



FIGS. 4 AND 5. CROSS SECTIONS THROUGH BOILER AND FIREBOX OF WINBY'S EXPRESS LOCOMOTIVE.

By courtesy of *The Engineer*.

ran upon the Chicago, Milwaukee and St. Paul railroad as stated, without achieving much success. The boiler gave considerable trouble, some of the stays leaked, and it was only with difficulty that proper head of steam was maintained, which circumstance, together with the manifestation of other weak points in the design, resulted in the engine being taken out of service and "laid up" at Milwaukee for some few years. A final and permanent resting place has at length been found for it, the trustees of Purdue University having secured it for the purpose of instruction to the students attached to the engineering classes there.

Unstinted praise was bestowed upon the character of the workmanship displayed in the construction of the engine, and considerable sympathy for Mr. Winby was felt both in England and America at the failure of his boldly conceived design. At all events one useful purpose was served; the experiment disposed of many theories held by various persons concerning boiler construction, and cleared up many points upon which considerable doubt had been felt among those whose circumstances did not allow of an opportunity of their own ideas being put to the test.

There was unmistakeable evidence of a great amount of ingenuity having been brought to bear upon the designing of this locomotive, and it seems tolerably certain that had Mr. Winby been content to adhere to the ordinary type of boiler, his engine would have met with a very large measure of success.

Space limits prevent the completion of the study of British practice in this issue. It will be concluded in the following number, and a final paper will deal with American and Continental types.

THE ISSUES BETWEEN LABOR AND CAPITAL.

✓

By Egbert P. Watson.

HAVING had a considerable experience with working men of many trades—at the vice and machine tools myself, and as an employer—I have been much interested in the present disorganized conditions whereby one working man's hand is raised against another, and all, or a very large portion are arrayed against employers. I have studied this aspect from all points that suggested themselves, in the hope of finding some solution which would be satisfactory to all concerned; but, as yet, I have not found any. Part of the trouble seems to lie in the great change in workingmen themselves in the last twenty years. Before that time, in the United States, at all events, they were free agents, chosing their own shops and employers, and, in the main, orderly, well-behaved, useful citizens. They did a fair days' work for fair wages, and employers dealt directly with each individual according to his merits. This system worked well, and there was no wide-spread dissatisfaction with it; but so soon as what is called organization became popular, trouble was experienced, and it has continued to this day. If American workmen were free to choose between allegiance to an employer and subservience to unions, with all their impositions and taxes, I believe, from observation and experience, that every union would be voted out of existence, and in saying this I am well aware of associations which have even arrayed themselves against the government, and are endeavoring to fix rules and regulations under which they will continue in the public service (the mail-carriers' association is one of them) but press reports do not express the opinions of the rank and file, only the utterances of persons interested in keeping the members in bondage. Workingmen are not free to vote as they please or to have opinions of any kind affecting the stability of associations. They are governed and held by two powerful agents, to wit: personal violence and ostracism. This last, while not dangerous to life or limb, is potent in the hands of unscrupulous men, and is all the more effective because the exhibition of it does not violate the law. No one, whether workman or business man, can long endure being sent to Coventry for no fault; and through this and the constant misrepresentations of so-called yellow journals, even conservative men are dragooned into supporting measures they do not believe in. This is, briefly, the condition of things today in most parts of the United States, and that it is contrary to common sense and the Constitution of the land everyone is aware.

What is the remedy? Opinions upon this point are diverse. Some amiable, well-meaning persons seem to think that much can be done by providing workmen with more or less luxurious retiring and lunch rooms, where they can meet at noon hour and talk together, under the refining surroundings of flowers and music if they wish to avail themselves of it; but these innovations are not general throughout the country, and, more than this, they are not popular with workingmen and women at large. I have heard a good many of them express themselves forcibly upon the subject of "fancy bath rooms," as they call them, and point to them as evidence that employers could pay higher wages if they chose to by carrying to the salary lists the money they cost to introduce and maintain. They look upon superior surroundings as charities, and, in some sense, as a reflection upon their social status, and will have none of them. Assuredly these provisions, intended to alleviate the irksomeness of labor, have done nothing toward establishing better feeling between capital and labor, or toward settling the issues between them, for one of the most obstinate strikes occurred in an establishment which was a model of the kind alluded to.

Another proposition to better the condition of workingmen is the profit-sharing scheme in one form or another. The difficulty with it as a permanent institution is that workmen have exaggerated ideas about profits, thinking that they run into fabulous sums, and, under the circumstances of their environment, it is not to be wondered at that they fall into such an error. They see supplies of all sorts purchased and lavishly used. The proprietors and officials generally have expensive establishments, are clothed in purple and fine linen, reck not of tomorrow, and, whether there are plenty of contracts on hand or none at all, spare not to spend. Under such conditions, I say, it is not surprising that workmen think that their gains from their daily work are too small, become restive, and demand higher wages, shorter hours, and more privileges generally. The leaders of unions dilate constantly upon this phase of the argument, sedulously harping upon the large amount of money employers make and the small sums they pay out. Therefore, when it came to sharing profits, the men naturally felt that there was a chance of getting more than they had been receiving, but they were disappointed; for the percentage allotted at the end of the year was pitifully small compared to their expectations, and really small in any light. A workman said to me that one experience of profit sharing was enough for him, for after working twice as hard as he ordinarily did and turning out a great deal more work, all he had to show for it at the end of one year was $75; as he got $3 per day his profit in 300 days was about 25 days, about one-sixth of what he felt it ought to have been. At the same rate, he said, he would have to work ten years to make $750; by that time he would be dead—under the high-pressure system.

Another objection to profit sharing is that workmen are not financiers, and have no way by which they can tell whether they are getting all they are entitled to or not. It may be urged that proprietors of shops and their bookkeepers would not descend to unfairness in such cases, but that is exactly what the men do not know, and it must be confessed that they are prone to be suspicious.

Let me digress a moment from the main issue of this article to comment upon a peculiarity of illiterate men as regards their wages, which is known to all who have had dealings with them, and that is their exact knowledge of the amount they should have. Not of course the gross sum to be paid them weekly, but for parts of a week, or day. I have seen coal heavers, when they have been laid off for one trip, raise the ship out of water pretty nearly with the racket they made over a difference of a few cents less than they thought they were entitled to, and in many cases they were right. They simply took what was given them, went on one side in the gangway, counted it, and if it was correct went about their business. If it was not, the purser would have a very bad quarter of an hour explaining how the mistake occurred. The men never credited explanations, but went away muttering objurgations. Mechanics are, of course, not ranked with coal heavers as to intelligence, but even they are prone to overrate the sums they think they should receive whenever extra compensation is in question.

Another scheme for benefitting workmen is to induce them to take stock in the concerns where they are employed, with the two-fold purpose of enabling them to make provision for old age, and, from the employer's point of view, of reducing the possibility of dissensions about wages, etc. By whatever name such propositions may be called, they are, when all is said and done, no more nor less than co-operative concerns, with the disabilities attached to organizations of this kind. These last are many; they take all the risks of every mercantile combination, and have some peculiar to themselves. Workmen-stockholders are hard to manage and to please; they know nothing about the routine of business, what it costs to get it, or to maintain shops and tools in working order, and fancy that so soon as any contract is completed some one stands with money in his hand to pay for it. Being all stockholders they have a voice in the direction, and cannot understand that they are unfit, for want of training, to make any suggestion at all. Co-operative shops consist usually of a force where every man is boss; then chaos comes again. The expectation is, in such schemes, that all will prosper from the start because interests are identical, and were it not for the fact that "in Adam's fall we sinned all" there would be no dissensions; but there is no prognostic for human nature, and where a number of workmen are gathered together the tower of Babel was a quiet tea party in comparison with the confusion of counsels exhibited.

In this discussion of the issues between labor and capital I do not give my own views wholly, as to the objections made to schemes to harmonize them, but have discussed the subject with intelligent workmen and employers as well, and from what they say I have come to the conclusion that they do not want to be "personally conducted," either as to their present or future prospects. This is quite natural, for every man prefers to work out his own commercial salvation, and, in so far as any Utopian plan is concerned, I do not think reliance should be placed upon it to bring universal peace to the warring factions.

Assuredly the union leaders, so called, do not desire interference of any kind between them and their ambitions. When workmen were first organized it was for the ostensible object of increasing their wages, but having succeeded in many cases in doing this they still maintain an aggressive attitude, with the object of getting recognition for their associations from employers. That is to say, they desire to have a voice in the management of affairs in shops where they are employed, to say who shall or shall not be employed, and to control the situation generally. They wish to "reap where they have not sowed," and to say what may or may not be done. A hat manufacturer recently wanted to put in a line of cheaper goods than he had been making in order to keep the shop going in a slack time, but the workmen decided that he must not do this, and when he insisted upon his right to do what he pleased with his own, every man in the shop quit incontinently. Instances like this one could be multiplied indefinitely and are of public knowledge; they are not isolated and of occasional occurence, but are examples of the "rule or ruin" attitude workmen assume toward employers at the present time. Is there any hope of a better day so long as this spirit is rife? Again, an employer in a small way of business who paid union rates had been so harrassed by dictation and walking delegates who watched every job he undertook, that he went to a meeting of the union men, and asked them to decide definitely what he must and must not do, so that he would have something to go by in future. They rose on him in a mass, with every foul epithet and threat of personal violence they could think of, and he was glad to escape without an assault. This state of affairs cannot be changed by mild measures, but must be dealt with as the law provides. We have just had in New York instances of the lack of principle in the trade unions which are cases in point. The treasurer of one sequestrated several thousand dollars of union money; he was put upon trial and is now serving out a term of years in State prison. Another, a walking delegate, went around mulcting employers in large sums to obtain immunity from strikes; unless contractors paid "smart money" the men were ordered off of the job, and they obeyed promptly. This man was tried and convicted of extortion, but had only served a few days of his sentence when he was released upon the pretence of some irregularity in the first trial, and is now out again.

Another proposition to settle the disputes between labor and capital was for them to meet and discuss moot points and arrive at some conclusion whereby mutual losses could be avoided in future. This was done in Chicago; both sides met and discussed. The verdict was that they should pool their issues. The capitalists were to find the money as they always had done, and the workmen were to do the work at their own prices, and, also at their own convenience. Certain capitalists and certain trades have formed a coalition which is a close corporation, and no outsiders or independent workers can contract to do anything, for they are not recognized as members of the association; unless they are, they might as well go out of business. Coal dealers agree to employ none but union men, and these last agree to work for none but the coal-dealers' union, so they have control of the situation as regards one of the staples of industry. Nothing could be simpler—the only difficulty with it being that it is in restraint of trade and therefore illegal; a trifle like this does not seem to stand in the way at present, for it is in full operation. Protests have been made, and some few persons fined for breaking the laws, but the city is so thoroughly saturated with the virus of unionism that every industry is paralyzed. A report recently published shows that unions have doubled their membership in Chicago in twelve months, and that there are now something like 240,000 men enrolled. The increase in the wages paid for labor amounts, for the same period, to $1,600,000. Is there any scheme or proposition which can be brought forward to offset this prosperity in the eyes of workingmen? I do not know of any. It is better than any stockholding or profit-sharing arrangement that can be devised, or has been put forward at the present time. Of course, it is neither more or less than commercial privateering, and like all illegal ventures will come to an end sooner or later, but this does not benefit those whose interests are now suffering from depredations.

It should be possible for every man to work when and where he pleases, and for whom he pleases; it was once so in the United States and it will be again, so soon as the laws are universally observed. Any body of men who attempt, without authority from the whole people, to dictate to other bodies of men as to lawful comings and goings, are without the pale of the law, and can be dispersed if the majority insist upon it. Usurpers are never the majority, and until the whole people demand all their rights again the arrogance of the self-constituted guardians of labor will continue. A union man was papering my house a few weeks ago, and when six o'clock came he still had ten minutes more work to do to finish. "Pull down the shades," he said, "and I will go ahead; if the business agent comes by here and sees me at work after hours I will be fined $25." Espionage of the closest kind, fines enormous in amount, and petty tyrannies at all times are visited upon members of unions without resentment or protest upon their part, and American workmen are bound hand and foot in chains of their own forging. American employers are somewhat in fault also, for the present conditions, by weakly submitting to extortion and dictation in the hope of being able to continue their contracts. Is it not somewhat incongruous that an employer should dicker with irresponsible men for a "privilege" that is already his by law and birthright?

Suppose that the employers of the United States decide that in future they will not hire any man or men without a contract for a certain time for stated wages. If the contract is fair in its provisions and both parties live up to it, there is an end to dissensions for a given time; if one or the other party ignores the instrument, there is a legal remedy, for courts everywhere consider contracts binding. The issue then is between man and man, as it was of old time, and the union is not a party to it. It may be said that this will be inoperative, for unions will not permit their members to make such contracts; in that event the issue is squarely against the union for depriving American workmen of their right to sell their services to the highest bidder, and that is a very serious indictment. Further, if picketing, tresspasses of walking delegates upon premises, and all unlawful acts were vigorously prosecuted, there would be a great improvement upon the present conditions. These measures are so easily tried that they should be.

DIAMOND MINING IN THE KIMBERLEY FIELD.

By Chas. V. Allen.

The Kimberley diamond mines, like the gold reefs of the Rand, afford an example of mining conditions under which "consolidation" is a legitimate and logical policy. Mr. Allen's present summary of the general history and methods of the region will be followed by a paper devoted especially to the mechanical equipment and appliances. For most of the illustrations accompanying this article we are indebted to the courtesy of Mr. Gardner F. Williams, author of "Diamond Mines of South Africa," and of his publishers, The Macmillan Company.—The Editors.

DURING the last 23 years, the output in rough diamonds of the South African mines has been approximately $414,000,000, the value of these diamonds when cut amounting to $828,000,000. Many thousand men are employed in the work of diamond cutting. This output is approximately 95 per cent. of the total product of all the diamond-bearing countries in the world.*

The first diamonds mined to any extent were in India, and later in Brazil, where diamonds were discovered by the Portugese in 1728.

In both countries, diamonds have been found to some considerable extent; the date of discovery in India, however, is not known. Here, as in Brazil, they were washed from the gravel, small claims being staked out to individuals, surface placer mining being the method followed. As diamond-bearing countries, Brazil and India amount to very little compared with the districts afterwards discovered near the junction of the Orange and Vaal rivers in South Africa. No diamonds of any amount have been found outside of Brazil, India, and South Africa. The diamond fields of South Africa were discovered in 1867, and it may prove interesting to know that the first diamond was discovered by a Boer, Van Niekerk by name, this diamond being found near the junction of the above mentioned rivers. It at first attracted attention as being merely a bright stone, and was sent to Dr. Atherstone, a leading mineralogist of the colony, who pronounced it a diamond. Its weight was 21.25 carats, and it was sold for $2,425 to Sir Philip Wodehouse, governor of Cape Town. Further search did not disclose other diamonds until 1869, when a few of smaller size were picked up by the natives. In 1869 a large white diamond, weighing 83.5 carats, was found on a farm near the Orange River. This was sold for a sum of 500 sheep, 10 oxen, and 1 horse, and later sold for $53,320 in Hope Town, and again sold for $121,250 to the Earl of Dudley, this diamond becoming known as the "Star of South Africa." Soon after this placer diamond mining was started on the Vaal river, with the result that more diamonds were found. The news spread rapidly, attracting all nationalities, until the banks of the stream for some distance were staked off into small claims, resulting in the forming of a town of 2,000 diggers, with stores and a newspaper.

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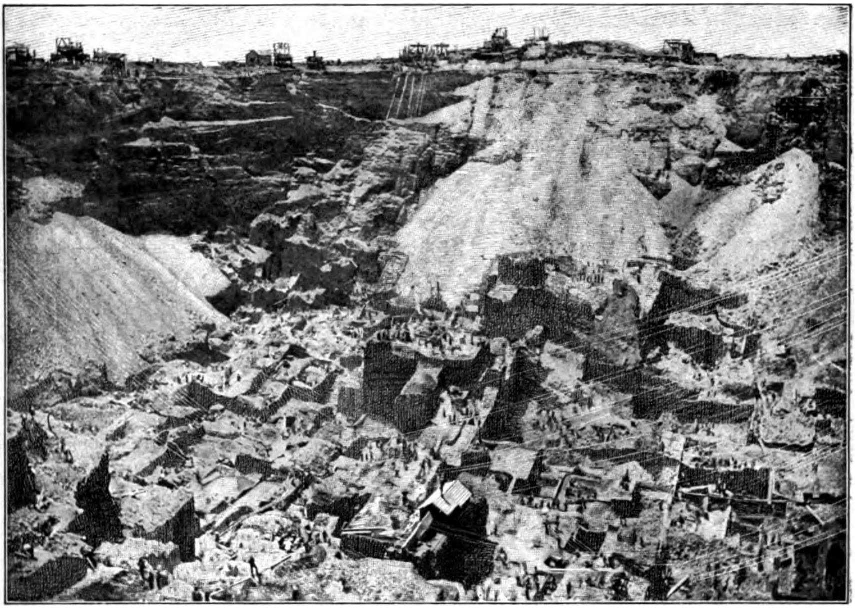
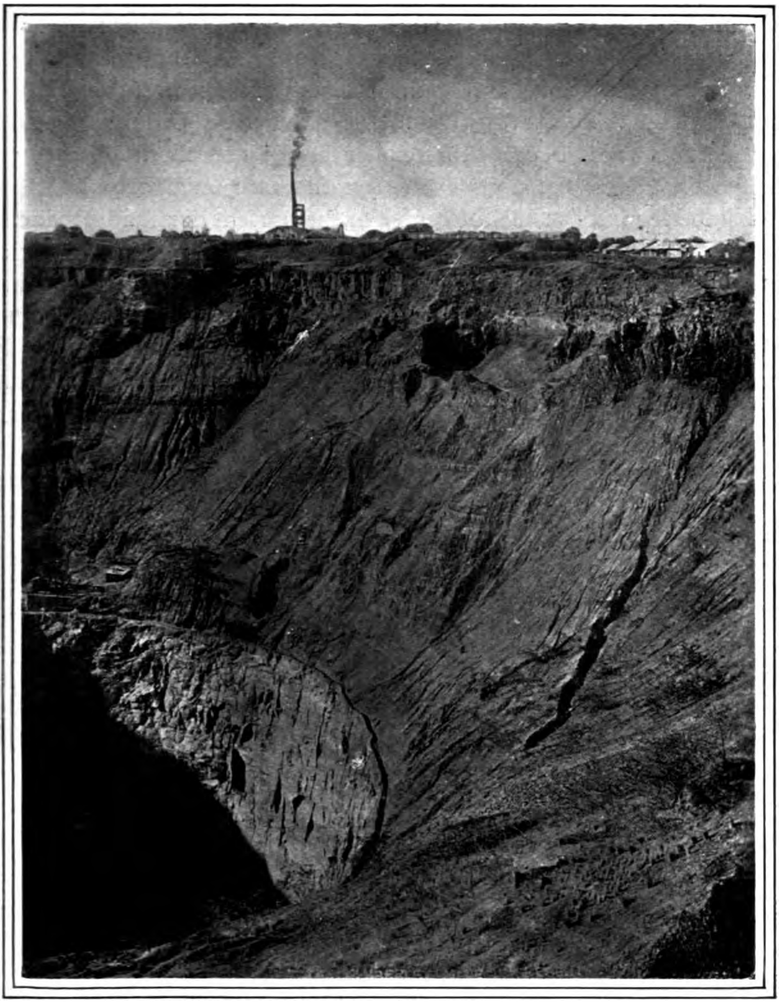
* It is estimated by an expert of international reputation that the value of the diamonds brought into the United States is approximately 75 per cent. of the valuation of all precious stones and pearls imported. This also represents fairly the percentage in other countries.



KIMBERLEY REEF SLOPES, 1874.

The finding of diamonds on the rivers led to further search in other districts, diamonds being found in 1870 at Jagersfontein. In 1871 diamond mining was started in Kimberley, claims being staked here as at previous places, each claim measuring 31 feet square with fourteen roadways 15 feet wide crossing the fields north and south 47 feet apart. At the river diggings it was not supposed that diamonds could be found below bed rock, or that they extended to much, if any, depth.

The surface of the country around Kimberley is covered with a red sandy soil, and it was soon ascertained that the diamond-bearing ground was located in sort of volcanic pipes or necks, which were probably at one time filled from below with a mixture of fragments of surrounding rocks mingled, forming the bluish colored, hard mass



THE KIMBERLEY MINE AT THE PRESENT DAY.

in which the diamond was embedded. This bluish color is due to the presence of lower oxides of iron, and this "blue ground," as it is known, is soapy to the touch, about the hardness of sandstone when mined, and readily friable when exposed to the air and moisture. In this blue ground Mr. Moissan has found some eighty species of minerals. The yellow ground is found below the surface red soil at a depth of 70 or 80 feet, and it was first supposed that diamonds, which were found abundantly in the yellow ground, would not be found in the blue ground beneath it. This theory proved erroneous, as time has shown, the yellow ground above being blue ground which has been acted upon by atmospheric influences, peroxidizing the iron and thus changing the color. The famous diamond mines in the neighborhood of Kimberley are the De Beers, Kimberley, Dutoitspan, Bultfontein, and Wesselton. Other mines in the neighborhood are now being worked for diamonds but as yet they are unimportant.

Kimberley has become the center of the present diamond-producing area, and a description of these mines, therefore, gives practically an outline of the world's diamond mines of today. Besides the mines above mentioned, there are two of some importance in the Orange Free State, known as Jagersfontein and Koffeefontein, about 60 miles from the Kimberley diamond region. The above five diamond mines are contained in a circle of three and a half miles in diameter, and comprise irregularly shaped round or oval pipes extending vertically downward to an unknown depth, keeping about the same diameter as far as they have been mined at the present time. The areas of the four principal mines are as follows:

Kimberley,	33	acres.
De Beers,	22	”
Dutoitspan,	45	”
Bultfontein,	36	”

Kimberley and De Beers mines were worked first from the surface and proved the most valuable of the four, these holes being sunk to a depth of several hundred feet. The rock outside of the mines is known as the "reef," and is not diamond-bearing. This reef caused no little trouble to the surface miners by its continually caving in and covering their individual claims. At one time, within the small area comprising the claims being worked open from the surface, there were 3,143 individual claims. Each of these was, as previously stated, 31 feet square, one digger being allowed to own and control but two claims. In the early mining the diamond-bearing ground was carried on wire ropes in rawhide buckets to the surface level. The yellow ground was at first sorted dry by screening the coarse ground out of it. Later it was washed in pans, and, when "blue ground" was struck, it was spread out exposed to the weather until it had sufficiently crumbled.

In November, 1883, 250,000 cubic yards of reef fell into the Kimberley mine, covering the tops of the claims half across the mine. In 1884 the first real underground mining was begun, a shaft being started in the reef, but abandoned as too expensive when 320 feet below the surface. In 1876 the population of Kimberley consisted of 8,000 whites and 12,000 to 16,000 blacks.

The need of proper organization in the mining industries was very much felt, owing to the fact that the mines, which were at times partially filled with water, required expensive pumping machinery to allow the mining to proceed, and again, the falling in of the reef was so troublesome as to render surface mining practically out of the question. The only alternative, therefore, was underground mining, but this was very expensive and could not be carried on by individual claim owners.

Up to 1885 there were still 98 separate holders in the four mines—in Kimberley 11 companies and 8 private owners, in De Beers 17 companies and 3 private owners, in Dutoitspan 6 companies and 21 private owners, and in Bultfontein 8 companies and 24 private owners. So that in the four mines there were 42 companies and 56 private owners, contending within an area of 70 acres comprising 3,600 claims; therefore, up to this time, after fourteen years of mining in the "each for himself" method, all claims had been thus far united.

At this time Cecil Rhodes became prominent in the diamond-mining history of South Africa. He was interested largely in the De Beers Mine, whereas Barnett Barnato, a former diamond buyer, was equally interested in the Kimberley Mine. In 1880 Rhodes formed the De Beers Mining Company with a capital of $570,000, comprising three firms. The same year, Barnato came into the control of the Kimberley Central Company. The contention between these two companies was considerable, each controlling one of the two largest diamond mines in the world. As a result of their fighting each other, the price of diamonds on the market dropped as low as $4.32 per carat. Rhodes, foreseeing the trouble and the difficulty of operating the mines successfully with this state of affairs, repeatedly tried to purchase Barnato's controlling stock in the Kimberley mine, and in 1889 succeeded, the price paid for the controlling stock in the Kimberley Central Company being $25,882,292, which payment was made by check, this check being the largest ever presented and paid in cash up to that time.

The name of the new organization was known as the "De Beers Consolidated Mines," this company later taking in a greater part of Dutoitspan and Bultfontein, which latter amounted to $70,375,000, although the capital of the De Beers Consolidated Mines remained at $19,157,500. After the combination, the net profit of the year was found to be over $4,850,000 and 20 per cent. was paid to the shareholders. This was a vast contrast to the result which had been obtained previous to the combination, when competition was in force. All the mines in the Kimberley divisions for this year produced an output of 2,415,655 carats, which was approximately 90 per cent. of the total product of diamonds for the year. The following table shows the increased production and valuation of diamonds from 1873 to 1888, the amount during the years from 1873 to 1880 being estimated.

Year.	Carats produced.	Value per carat.	Total value.
1873-1880	1 to 1,500,000	——	————
1883	2,319,234	$4.89	$11,352,640.00
1884	2,264,786	5.57	12,406,181.00
1885	2,287,261	4.61	10,515,709.00
1886	3,047,640	5.16	15,740.060.00
1887	3,646,889	5.16	15,819,947.00
1888	3.565,780	5.29	18,862,976.00

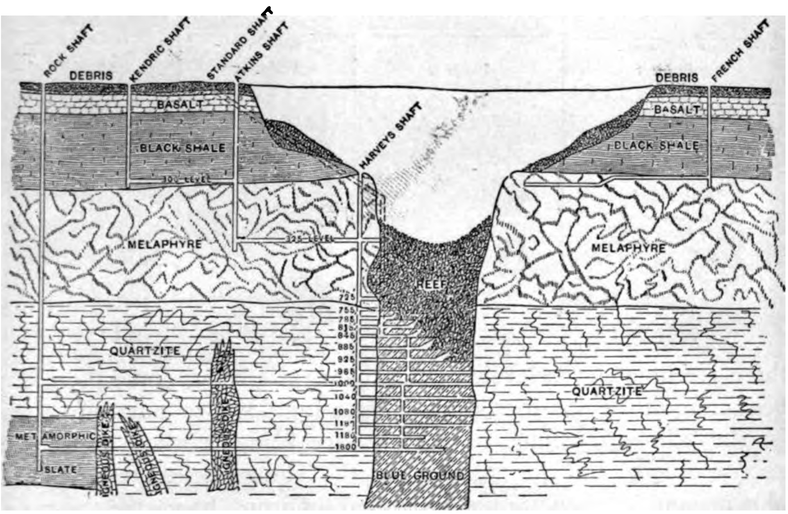
The contents of the several pipes constituting the different mines differ decidedly in character. The diamonds of each mine have a distinctive character, so much so that an experienced buyer can tell by the appearance of a stone the mine from which it is taken. Dutoitspan yields principally white stones; Bultfontein, small white stones; Wesselton, clear stones of irregular shape, mostly white. The diamonds from Jagersfontein in the Orange Free State are extremely rare in color, having a steely sort of lustre. These stones are worth nearly double those from Kimberley and De Beers.

In order to get an idea of the enormous value of the Kimberley mines, it might be well to state that two claims measuring together 62 by 31 feet and worked to a depth of 150 feet produced 28,000 carats of diamonds. The blue ground varies in the amount of diamonds it contains in the different mines, but remains fairly constant in any one mine. In 1890, the yield per load of blue ground (each load weighing 1,600 pounds) was:

Kimberley Mine	1.25 to 1.5	carats.
De Beers Mine	1.20 to 1.33	"
Dutoitspan Mine	.17 to .5	"
Bultfontein Mine	.5 to .33	"

Underground Mining.—After the consolidation of all these mining interests, Gardner F. Williams, who had been in charge of the De Beers Mine since 1887, assumed management of the entire consolidated interests. It was at this time that a great number of engineering problems had to be solved, inasmuch as surface mining must necessarily be done away with and some method of obtaining the valuable blue ground by a system of underground mining must be developed. After some years of careful study and much expensive experimenting, the method of underground mining at present in use was adopted, which is very well described by Sir William Crookes after a visit.

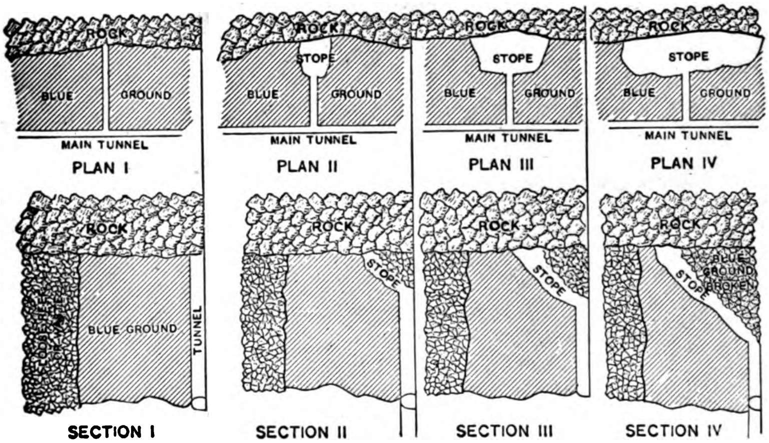
SECTION OF KIMBERLEY MINE
LOOKING EAST



"Shafts are sunk in the solid rock at a sufficient distance from a pipe to be quite safe against reef movements in the open mine. The main shaft at De Beers starts about 540 feet from the north side of the mine, and is now over 1,500 feet deep. Tunnels are driven from the shafts at different levels to cross the mine from west to east, about 120 feet apart. These tunnels are connected with each other by two tunnels running north and south, one near the west side of the mine, and one midway between it and the east margin of the mine. From the east and west tunnels offsets are driven to the surrounding rock. When near the rock, they are widened into galleries, these in turn being stoped on the sides until they meet, and upwards until they break through the blue ground. The fallen reef, with which the upper part of the mine is filled, sinks and partially fills the open space. The workmen stand on the falling reef, and drill the blue ground overhead; as the roof is blasted back, the débris follows. When stoping between two tunnels, the blue is stoped up to the débris about midway between the two tunnels. The upper levels are worked back in advance of the lower levels, and the works assume the shape of irregular terraces. The main levels are 320 feet apart, with intermediate levels every 40 feet. Hoisting is done from only one main level at a time. By this ingenious method of mining, every portion of blue ground is excavated and raised to the surface, the rubbish on the top gradually sinking down and taking its place."

The interior of the diamond mines resembles not a little the appearance of a coal mine in its method of working. In the De Beers mine

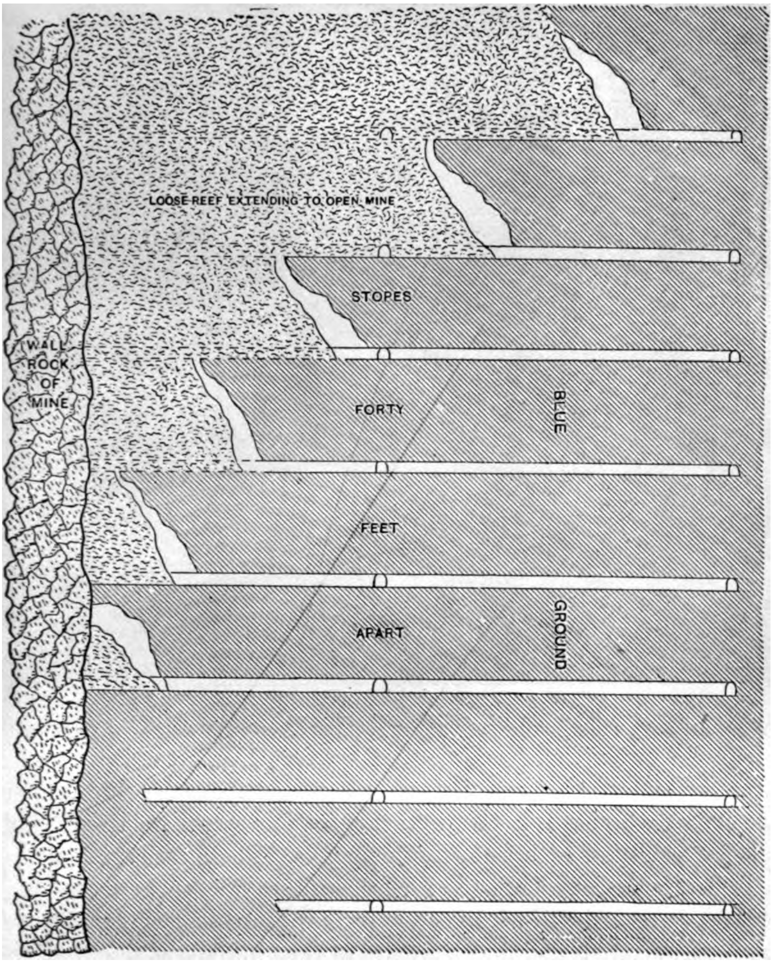
SKETCH SHOWING METHOD OF STOPING



there are now eleven levels on which work is being done, these levels beginning at the 800-foot level and running down to a 1200-foot level. In the Kimberley mine nine levels are being worked between the 1200-foot level and the 1500-foot level. The galleries from which the blue ground is taken are not supported by props, however; the tunnels in the blue ground are supported at intervals by two heavy props, having a cap of round timber over them, this being covered by 1½-inch lagging.

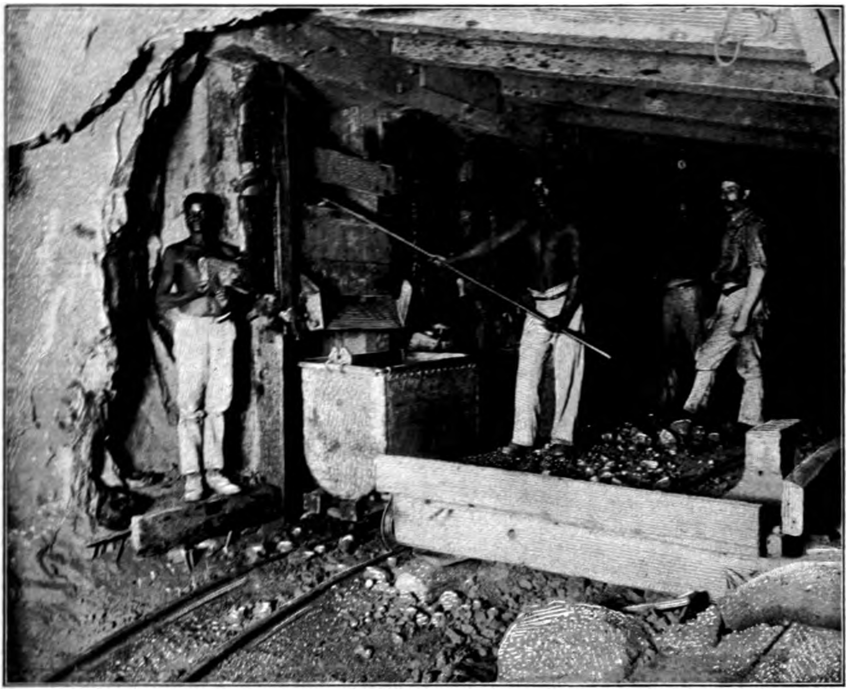
Parts of this ground are quite soft, whereas other parts are more of the hardness of sandstone, as previously stated. The soft blue ground can be drilled with what is called "long jumper drills," which are sharpened at both ends, whereas the hard blue is drilled in the usual way, using single hand hammers. In this work, natives are employed almost entirely, and after a time become very skilled in their work, performing quite as much as would white men under similar conditions. The mined blue ground is shovelled into trucks holding 16 cubic feet and hauled along tunnels by endless chains. The motive power until recently has been compressed-air engines, the air being piped in from the surface. These are being supplanted by motors. The trucks of blue ground are run into a large station about 30 by 70 feet cut out of the solid rock back toward the mine from the shaft, the tunnels themselves being 8 by 11 feet. This blue ground is emptied from the trucks into chutes, and from them turned into the skips and hoisted to the surface, each skip holding six trucks full, or 96 cubic feet, the weight of each truck load of blue being 1,600 pounds.

The tipping of trucks into the loading chutes at the bottom of the



VERTICAL SECTION, SHOWING METHOD OF STOPING.

various shafts has hitherto been done by means of the ordinary revolving tippler, and the expense for labor in connection with this has been high. This is now accomplished by using 20-cubic-feet side-tipping trucks instead of the old 16-cubic-feet end tippers, the trucks leaving the electric haulage line and running by gravity round the shaft, being tipped and righted automatically, and coming back again for attachment to the haulage without requiring any labor except that necessary for reattachment to the haulage rope. This has resulted in reducing the working cost and makes the handling of larger quantities of ground



LOADING THE TRUCKS.

possible. For hoisting from the 1,520-foot level, 40 seconds is required. After the blue reaches the surface, it is tipped from the skip into surface chutes where it is drawn into side-tipping trucks holding 20 cubic feet, the weight of each being 2,000 pounds. These cars are hauled by an endless wire-rope haulage to the depositing floors where the blue is spread out to a depth of one foot for exposure to weather, in order that it may crumble and thus be easily worked in the washing machines.

These trucks in passing from the mouth of the mine shaft to the depositing floors are greased automatically while in transit, and every fourth in passing to these floors registers automatically as five loads of 16 cubic feet, making 80 cubic feet in all in the four trucks. Each truck load is spread out to cover about twenty-one square feet. The exposure to the sun and rain causes the blue ground to crumble, and it is harrowed occasionally by steam traction engines drawing wheeled harrows with huge teeth back and forth over the floors, turning and returning the lumps. The hardness of the blue ground varies in the different mines. In the Kimberley, it becomes well pulverized after three months' exposure, whereas the De Beers product requires approximately six months. The longer the exposure, however, to which the ground is subjected, the more pulverized it becomes and consequently the better for washing.

These floors extend over many square miles of country and are surrounded by a 7-foot barb-wire fence, this being guarded by day and night. Powerful 2,500-candle-power search lights are thrown across these floors all night to prevent theft. On account of the long exposure necessary, especially in the case of the De Beers blue ground (which contains a much larger quantity of hard blue than do the others), the harder lumps are of late being passed through crushing mills, in order to hasten the process, and consequently not to tie up so much capital for so long. It is estimated that about 14 per cent. of all the ground sent to the depositing floors is too hard to weather.

Before referring to the method of extracting the diamonds from the blue ground, we will return to the mines. Here among some of the engineering problems which have to be met with is the matter of drainage. At first, steam pumps were used to pump the water from the mines, this steam being piped down the shafts, as a result of which the moisture and heat cause the blue ground near at hand to crumble, the ladder ways in the shafts at times proving impassable on account of the excessive heat. The water pumped from the mines is used at the surface to aid in the pulverizing of the blue ground deposited upon the floors, as in some seasons there is very little rainfall, so that the action of the elements upon the blue ground is extremely slow if it be left to nature. The supply of water about Kimberley would be insufficient for this purpose were it not for that obtained from the mines. The amount of water pumped at the De Beers mines in 1889 was approximately 6,000 gallons per hour, and the pumping was accomplished by a compound surface-condensing 120-horse-power engine, made by James Simpson & Company of London, the high-pressure cylinder being 14¾ inches diameter, low pressure 21 inches, stroke 30 inches. At the Kimberley mine in 1891 there was installed a Cornish pumping engine of 400 horse-power, this being a triple-expansion condensing engine with cylinders 15½ inches, 23¼ inches and 27 inches diameter, 36 inches stroke. This engine pumped on an average 12,000 gallons a day. Compressed air has heretofore been used in the mines, replacing steam for driving sinking engines, mechanical haulages, rock drills, and the like. At this writing, a still further development is found in the adoption of electricity.

A problem which has still further troubled the engineers of this vast mining industry is the prevention of what is known as "mud rushes." Water accumulates in the open mine above and finds its way below through the debris, finally breaking through into the tun-found in the adoption of electricity for supplying a greatly needed want, nels with a rush, filling them in a few minutes with a quantity of mud and oftentimes causing loss of life on account of the impossibility of the workmen in the tunnels making their escape. In order to obviate this, various methods were tried, until now the mines are well drained by special passes in the rock. Tunnels have been made around the open mine, in order to catch the water and prevent it from entering the mine.

Another problem which has been more easily solved has been that of lighting the various shafts, tunnels, and galleries. Electricity has now been adopted entirely for lighting purposes throughout the various underground tunnels, as also for the various ladder ways. In the stopes, however, and other places which are being worked, candles are still used. The lighting of the tunnels by electricity has proved especially valuable in aiding the men to escape from the mud rushes.

For some time electric bells and telephones have been generally installed throughout the entire mine, the bells being used in connection with the hoisting, thus saving a great deal of time over the old method; the telephone system is now very extensive throughout the entire plant, connecting depositing floors, concentrating works, offices, and the various underground levels.

The veltilation of the mines is another problem which must be met, and in the case of the De Beers and Kimberley mines this is provided for to a great extent by natural air currents. In the case of the De Beers mine, the air passing in and out amounts to 145,000 cubic feet per minute, and in the Kimberley mines, 25,500 cubic feet per minute.

In these mines there were employed in 1897 above ground 1,126 whites and 3,528 blacks; underground, 500 whites and 3,812 blacks, thus making a total of 8,966 in all. The number employed have increased to quite an extent since then, until from 10,000 to 12,000 are at present at work in and about the mines. These men receive compensation for their work as follows:

Mechanics	$24.25	to	$33.95	per week.
Miners	24.25	to	29.10	"
Guards and tally men	19.40	to	24.25	"
Engine drivers	29.10	to	33.95	"
Natives working blue ground	.72	to	1.20	per day.
Overseers	17.45	to	19.88	per week.
Machine men and assorters	24.25	to	29.10	"
Ordinary native laborers	4.00	to	3.04	"
Drivers	6.00	to	6.60	"

In addition to the above, a premium is paid each employee in proportion to the value of the diamonds found by him, either on the depositing floors or within the mines. On the floors the white men receive 36 cents and the natives 6 cents per carat. About double these amounts are paid for stones found in the mines.

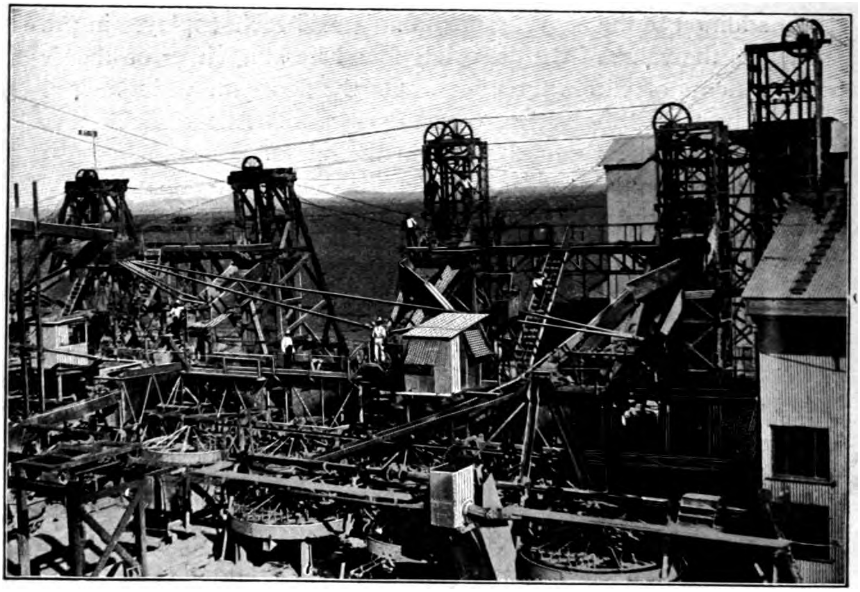
The blue ground is now mined, deposited, and watered at a cost of 52 cents per load, the average yield of diamonds for the last several years under the present management having been 3/10 of a carat per load from Premier mine, and about 8/10 of a carat from De Beers and Kimberley mines.

It was found that the Dutoitspan mine could not be worked further from the surface to advantage so that at the end of 1889 work was suspended, the market at that time being well enough supplied with diamonds. In 1901 a shaft was started at this mine for future underground working.

The Bultfontein mine proved more profitable than the Dutoitspan; however, in 1889 a large reef fall covered nearly the entire open mine so that work was shortly afterwards suspended until 1900. During the past few years this mine has been opened up for underground mining and is now ready to be worked on a large scale. The shaft is down to the 600 feet level, above which there are 13,000,000 loads, equal to 10,400,000 tons of the blue ground in sight.

The methods pursued in extracting the diamonds from the valuable blue ground necessitate considerable handling before the diamond is ready for the market. However, the ancient laborious methods of sorting such diamonds and washing by hand have been greatly improved, until we now find labor-saving machines doing almost all the work. The methods of extracting diamonds we may refer to herein briefly.

The ground is taken from the depositing floors and hauled in 20 cubic foot trucks by wire rope to the washing machines, where it is dumped automatically into hoppers, the bottoms of which are small revolving tables. Here the ground is divided and automatically conveyed by motor-driven belt conveyors into revolving cylinders. This automatic feeder not only divides the ground equally between the rotating washing machines, but delivers it regularly so that the machines cannot become overcharged, the result of which would be the loss of many diamonds. There is one of these cylinders for each section of the machine, each cylinder being capable of sizing 2,000 to 3,000 loads per day. After leaving the automatic feeders the ground is mixed with "puddle," a thick muddy water, which flows out of the



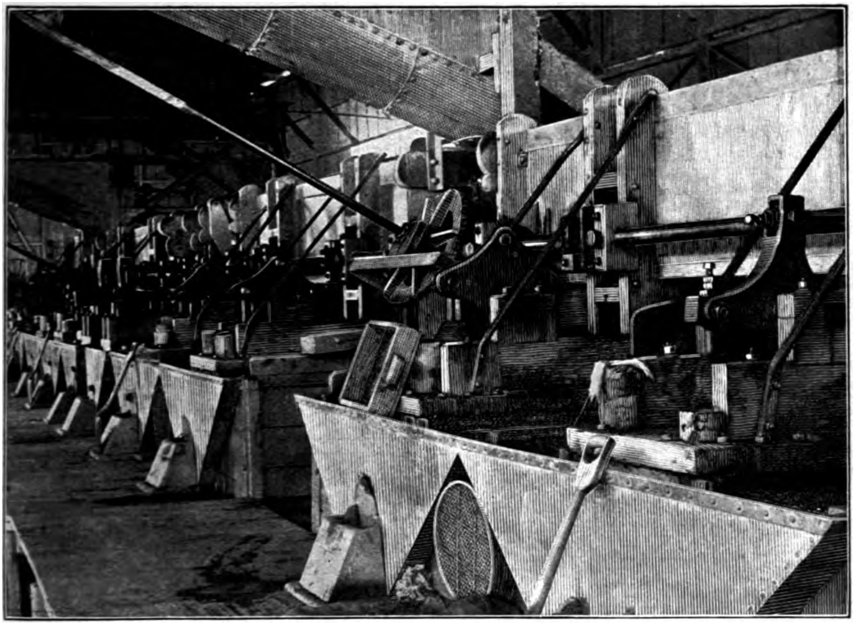
NO. 2 WASHING PLANT, DE BEERS FLOORS.

washing pans, clear water being added constantly. This mixture then flows into a revolving cylinder covered with perforated steel plates having holes 1¼ inches in diameter, all lumps larger than the holes passing out of the end of the cylinder and being carried by a motor-driven pan conveyor to crushing rolls for further treatment.

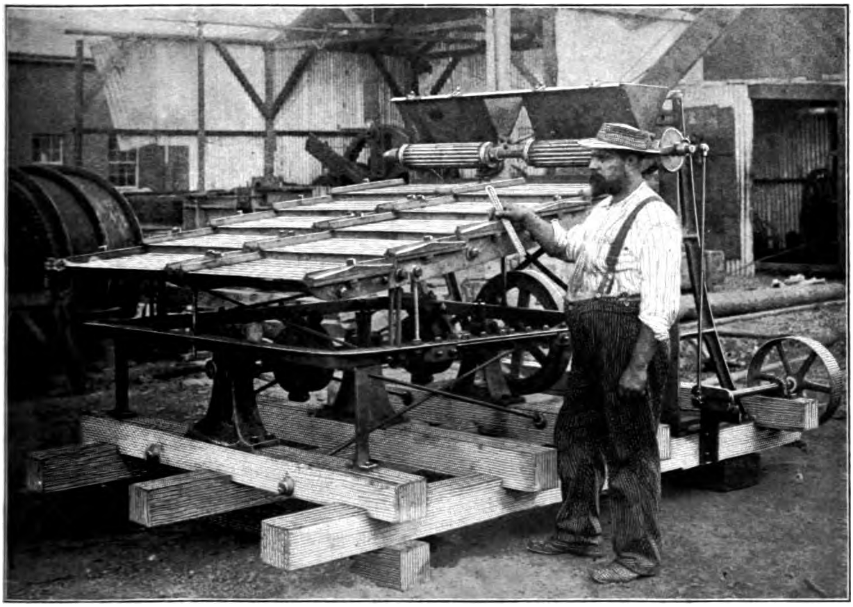
That which goes though the holes of the screen passes into shallow circular pans, where the ground is carried around by revolving arms with teeth so that the diamonds and heavier matter pass to the outside and the lighter matter flows out at the discharge in the inner rim; thence it goes through a screen, and is finally carried away by an endless chain of buckets to the waste heaps.

All the pans are fitted with patent extractors, by means of which the diamonds deposited are removed every two hours. The entire gear is driven by means of three 220-volt electric motors. Suitable motors have been installed at various points, and the drives so arranged that one motor drives two pans. The coarse rolls and the fine rolls are also arranged to be driven by separate motors. The various conveyors, screening cylinders, etc., are motor-driven.

As a result of this treatment there is obtained what is called concentrated deposits or "concentrate." This concentrate is then sent in covered locked trucks to what are known as the "pulsators," where it is



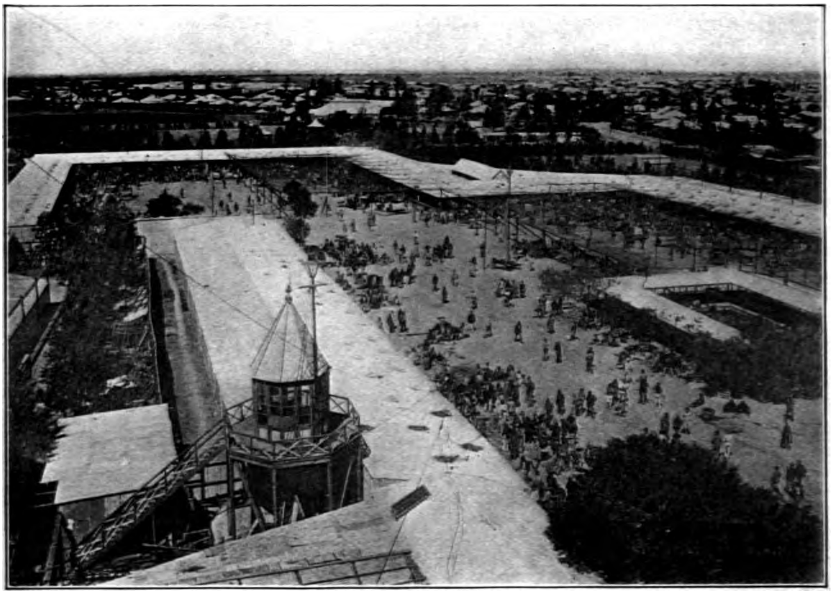
THE PULSATOR.



AUTOMATIC DIAMOND SORTER, CALLED THE GREASER.

divided into various sizes by passing through a cylinder covered with steel sieving with holes 1/16 to 5/8 inch diameter. Through these five sizes of holes the stones fall and pass from the pulsators by means of conveyors to small hoppers located above mechanical sorters called "greasers," or grease tables.

For a long time it was considered possible to extract the diamonds from the concentrate left after passing through the pulsators only by careful and repeated hand sorting, the concentrate passing first through the hands of white sorters and later native employees. This tedious process was studied carefully by many, and finally Mr. Kirsten invented a machine known as the "greaser." He noticed that diamonds and other precious stones adhered to grease, wheres other substances seemed to pass over it. As a consequence, therefore, after much experimenting, he developed the mechanical sorter which consists of a sort of table built up of various steps, these steps being one above the other and each on quite a little incline. These step surfaces are covered with grease and vibrated rapidly. The concentrate is allowed to drop on the table gradually from the hopper above, and in passing over the various steps of the table the diamonds adhere to the grease. The first table recovers all but 1/3 of 1 per cent. of the diamonds, the con-



THE DE BEERS COMPOUND, OR LIVING QUARTERS OF BLACK LABORERS.

centrate afterwards being passed over a second table where practically all of the diamonds are collected. The grease on these tables is renewed every few hours, the old being scraped off and steamed in kettles to separate, the grease passing away to tanks of water where it is cooled and again ready for use. The diamonds are then boiled in caustic soda to get rid of the grease.

Before the invention of these grease sorting machines, out of 12,000 loads or 192,000 cubic feet of blue ground washed daily at the De Beers and Kimberley mines 160 cubic feet had to be sorted by hand. With the above mechanical sorter now but about 1 cubic foot reaches the hand-sorting table, the saving being due to the efficiency of these mechanical sorters, which fact well illustrates the vast importance and value of such invention.

In making mention of these labor-saving inventions it might be added that a machine for loading the blue ground from the floors direct into the trucks which haul it to the washing machines is now being experimented upon.

The diamonds, which have now been separated, are taken under armed escort to the valuators in the general offices, where they are cleansed by boiling in a mixture of nitric and hydrochloric acids or in fluoric acid; after this they are sorted carefully as to size, color, purity, and made into parcels for sale.

To provide for the ten or twelve thousand men employed in or about these mines the management have had many problems to meet which were all aside from the mining problems themselves. There are now in use at these mines twelve compounds, the largest being at the De Beers mine. This one covers four acres and provides shelter for 3,000 people. Provisions and essentials can be bought at the compound store, there being an understanding with the local dealers in the town and the government so that they only sell the necessaries of life, the price being the same as at outside stores. In addition to this the compound is provided with a hospital, dispensary, church, and school. A large concrete swimming pool occupies the centre of the enclosure. The native's cabins or rooms are situated on the outside of the grounds forming a square or rectangular area in the centre. These cabins are lighted by electricity. All applicants for positions must sign contracts binding themselves to live in these compounds at least three months, and longer if they desire, not being allowed to leave until their contract expires.

Every possible protection is taken to prevent loss of diamonds by theft, the men being examined twice daily to make sure none are concealed about the person. These examinations take place upon entering and leaving the mine.

The underground work in the mine is conducted day and night in three shifts. Contractors employ natives to mine and truck the diamond ground at a fixed sum per load; however, a worker must drill a certain number of holes for blasting or load a fixed number of trucks before he has earned his compensation. These natives usually work in gangs of ten or twelve, those of the various tribes being kept together at their work as well as in the compounds. All natives are placed under responsible white overseers.

As giving an idea of the enormous growth of this industry since its consolidation, the following table, which is taken from the De Beers Company's report of 1902, may prove interesting. The increased price of the diamonds since competition was renewed at the time of consolidation is plainly seen.

De Beers and Kimberley Mines.

	Year ending March 31, 1889.	Year ending June 30, 1894.	Year ending June 30, 1896.	Year ending June 30, 1898.
No. of loads of blue hoisted...	944,706	2,999,431	2,698,109	3,332,688
No. of carats of diamonds found	914,121	2,308,463	2,363,437	2,603,250
Value of diamonds produced...	$4,373,817	$13,677,825	$15,352,103	$16,738,391
No. of carats per load.........	1.283	.89	.91	.80
Value per carat	$4.73	$5.86	$6.42	$6.36
Value per load	$6.07	$5.25	$5.84	$5.06
Cost of production per load...	$2.37	$1.56	$1.68	$1.58

		Premier Mine.		Bultfontein Mine.
	Year ending June 30, 1902.	Year ending June 30, 1898.	Year ending June 30, 1902.	Year ending June 30, 1902.
No. of loads of blue hoisted...	2,062,459	1,146,984	1,932,140	353,042
No. of carats of diamonds found	1,499,299	189,356	521,437	4,486
Value of diamonds produced...	$4,373,817	$13,677,825	$15,352,103	$16,738,391
No. of carats per load	.76	.27	.30	.21
Value per carat	$11.15	$4.98	$8.04	$7.27
Value per load	$8.52	$1.36	$2.39	$1.62
Cost of production per load...	$2.02	$ .62	$ .82	$1.56

EDITORIAL COMMENT

OUT of the fog which veils the march of events—or the progress of palaver—in Bogotá, as we go to press, come many and diverse rumors. The semi-mediæval remoteness and isolation of the Colombian capital are conditions highly favorable to the breeding of *canards;* the long silences of the interrupted communication are the chosen times for the stalking abroad of the "high authority" and the flight of the "special dispatch." Mr. Leigh's leading article in this number gives a most interesting and useful picture of the condition of the mainland of the Republic—territorially far superior to the isthmus, politically the most difficult and yet the controlling element, but almost unknown, probably, to many who have an excellent knowledge of the single small State of Panama. The knowledge of the country and the people thus given is materially helpful in reaching an understanding of the Colombian congress in which, as we write, the treaty is still being debated.

Criticism of this legislative assembly, as Mr. Leigh well remarks, is largely forestalled by the embarrassing recollections of the weeks of futile debate in our own Congress. We were not always nationally wise in seeing the truth, even when it stared us in the face. Memories of Senator Morgan must temper our impulse to lose patience with the senators at Bogotá. Neither dignity nor common sense would be served if at the first petulent outfling of a petty State we should abandon our tacit undertaking to give the world the best waterway, and turn in meek discouragement to an inferior course. But of this line of action there is now, we believe, fortunately very little fear.

* * *

THE difference between professional and political investigation of an engineering matter is most strikingly shown by a comparison of two reports upon transportation in New York City—the one issued by the State railroad commissioners in June, the other by the engineering and sanitation committee of the Merchants' Association in September. The gentlemen from Albany put forth the results of their labors in a little pamphlet of 24 pages, 14 of them filled with tables valuable only as the bases for analyses or comparisons which the State officials do not make. The text is very largely an expression of vaguely amiable and hopeful opinions that everything is going to be very nice. "There has been an improvement on all of the lines." "We believe a marked change for the better will be shown." The companies have promised many things—for example, the widening and other improvement of a number of downtown stairways "as soon as practical," the changing of many crosstown lines to underground electricity, the immediate increase of power for the Brooklyn lines—and the commissioners, in happy contentment, say: "There—that's fixed!" But they can be stern when requisite. They have ordered "that the elevated cars be painted as early as practicable," that "clearly legible signs reading 'Smoking on five rear seats only' be placed in each car in which smoking is allowed," and that "the grab handle on the bell shaft be remodeled so as to be about seven inches nearer the conductor."

And yet the congestion of traffic is not relieved!

It is a deep satisfaction to turn from this Gilbert and Sullivan production to the thorough and earnest study by the engineers of the Merchants' Committee on Engineering and Sanitation. It makes a book of 216 pages, of which about 90 are tables and diagrams directly pertinent to the text. The systematic arrangement of the study is admirable, the results well digested, well presented, and well supported by evidence, and the remedies proposed in almost every case are temperate, practicable, and such as commend themselves to common sense and justice.

* * *

THERE has been much wise talk emitted concerning the importance of technical education to the engineer, while at the same time it is often painfully evident that certain portions of some more elementary branches might also be included. It has been said that an engineer's first duty is to do things, but he is often called upon to say things as well as to write about the things he has done or is doing. For this purpose a full command of at least one language is essential, and yet attention has frequently been drawn to the fact that many otherwise able engineers are deficient in the ability to use their native language in such a manner as to express themselves clearly and correctly.

There are, of course, brilliant examples of engineers whose expression is as clear and direct as their thought—whose words are as well chosen as the materials of construction they build into their work—whose writings are ls of strong, simple language, well but in many instances the papers which are submitted to technical societies and technical periodicals would create much surprise if published exactly as written, and the combination of eminent names and curious English might in some cases produce an impression almost painful.

It is by no means desirable that an engineer should also be trained to write a highly polished literary style, and any tendency toward "fine writing" would be most ludicrous, but he should at least be able to write a report, or prepare a paper for a professional society, without making blunders for which a schoolboy would be punished or a stenographer reprimanded.

That such a deficiency lies in the training must be apparent. A man must be able to think clearly before he can become a good engineer, and the training in pure and applied mathematics through which he must pass cannot fail to impress upon him the necessity for accuracy in the statement of facts when he uses formulas, tables, or diagrams. With the instincts of an engineer, with the knowledge of the necessity for absolute accuracy in the selection of data and the deduction of results, a man must have the capacity for becoming a master of clear and intelligible English, if only he is given proper opportunity. The diplomat may well say that "language was given to enable us to conceal our thoughts," but engineering and diplomacy have different ends in view and may well use the same tools to attain different ends.

The present agitation for higher as well as more practical technical training will certainly be incomplete if it fails to include fuller and better methods for instruction in the right use of the English language as an effective and essential instrument for the use of the engineer in his work of directing the great sources of power in nature for the use and convenience of man.

REVIEW OF THE ENGINEERING PRESS.

"THE WORLD IS ITS FIELD"

MODERN TRANSATLANTIC STEAMSHIPS

THE SUCCESS OF THE HIGH-SPEED GERMAN VESSELS AS COMPARED WITH BRITISH AND AMERICAN LINES.

Engineering.

IN a recent editorial in *Engineering* the question of Britain's supremacy on the Atlantic is discussed and a comparison is made betwen the popularity and success of the more modern German vessels and the best ships of the British and American lines. This discussion is apropos of the formal completion and signing of the agreement between the government and the Cunard Steamship Company and the efforts to be made by the British line to regain the position which has been lost.

Since the completion of the Campania and Lucania, more than ten years ago, no serious attempt has been made by British naval designers to exceed the speed of those vessels, about 22 knots, and England has apparently remained content to allow her mails to be carried across the Atlantic more slowly in vessels sailing under her own flag than can be done by the foreigner; ignoring in the councils of her government, the inquiries which have been made as to the reasons why both Englishmen and Americans have to mark their letters especially for the German vessels which may choose to call at her ports, rather than to entrust them to the Post Office to see that the best possible service shall be had.

The travelling public, quite willing, to choose the best, under whatever flag it may be found, has not been slow to express its appreciation of the superior service afforded by the German vessels, and, as *Engineering* remarks, it is only necessary to examine the returns of the passengers embarking on various ships to reveal the preference shown, not only for the high-speed vessels, but for the vessels which give the most satisfactory service in all respects. Without going into the details of the lists it will suffice to say that during the later weeks of April and the earlier part of May of the present year, when the east-bound traffic was beginning to assume its best proportions, the swift German vessels took out from three to five times as many first-class passengers as did the best British and American boats. In one week one of the best German boats carried as many first-class passengers as did the four other vessels of the same week, these latter boats being American, British and French. The same results are shown by an examination of the west-bound lists in the later season, when the same passengers were returning to the United States, thus showing that the experience on the one voyage led to its repetition on the return.

As to the cause of this preference for the German boats, there are several points to be considered. The writer of the editorial in *Engineering* dwells upon the preference of the travelling public for high speed, and in many instances this is doubtless the controlling influence. Apart from the advantages gained by controlling the maximum speed for the purposes of carrying the mails, the government is interested in the provision for vessels of maximum speed which may serve as cruisers in event of war, and it is this latter contingency which has doubtless led to the stringent provisions of the agreement with regard to the speed of the proposed ships for the Cunard line. The agreement between the government and the Cunard Steamship Company is of sufficient interest to be examined here. The amount to build the two steamships, necessarily large, but dimensions not stated, is £2,600,000, this to be furnished by the government, and secured on debentures at 2¾ per cent. interest, while an additional annual payment of £150,000 is to be made upon the condition that the ships shall be capable of making a minimum average speed of 24½ knots in moderate weather. If this speed is not maintained, a deduction is to be made from the annual payment by agreement, provided the speed does not fall below 23½ knots. What is to happen if the speed falls below 23½ knots does not seem to be altogether clear, but apparently the ships may either be rejected, or their fate is to be determined by arbitration.

Apparently the real incentive which has led to the advancement of government aid to a private company is the fact that the organization of the International Mercantile Marine Company practically took the control of the fast White Star steamships, upon which the government had relied in time of war, out of British hands. Into the exact facts of this feature of the case it is not now necessary to go, as it is sufficient to know that what the effective competition of the German lines could not accomplish has been effected by the realization of the fact that naval strength might be impaired.

According to *Engineering*, the designs for the new ships are in an advanced stage, and although it is not yet announced by whom they will be built, it is understood that one of them will be built on the Clyde and one on the Northeast Coast. They are to be built to plans and specifications approved by the Admiralty, and, in conformity with naval practice it is the intention to make the machinery in both cases in duplicate, or in other words, to adopt as far as possible the principles of standardization. An inspector is to be appointed mutually by the Admiralty and by the Cunard company to carry out the work according to the plans and specifications approved, so that the ships will represent the best that British mechanical constructors can give, and will also be the most satisfactory compromise between the requirements of passenger and mail service and of cruiser duty in time of war.

Apart from the incentive of high speed and quick crossings, however, there are other things which affect the partiality of the travelling public for the German transatlantic steamers. First and foremost, a ship is intended to cope with the perils of the sea to the very best possible degree, and in this respect British-built vessels and British seamen stand in the first rank. Skill and safety being granted, the ocean liner is next considered as a hotel, and as first-class hotels the German vessels are so infinitely superior to the English boats that the traveller is quick to recognize the difference. On an English vessel the passenger is made to feel that he is altogether subordinate to the details of administration, while on the German vessels the entire relation of the service to the passengers is reversed, and there is the same systematic, effective, and courteous personal service which is found in a first-class Continental hotel. There is little doubt that it is this question of superior service, and careful attention to the personal comfort of the passengers which is turning the bulk of ocean travel to the vessels of the Continental lines, and this element can be met without the expense and delay of building larger and swifter ships.

THE THEORY OF NICKEL-STEEL ALLOYS.

DEDUCTIONS FROM THE EXPERIMENTAL INVESTIGATIONS CONDUCTED AT THE INTERNATIONAL BUREAU OF WEIGHTS AND MEASURES.

C. E. Guillaume—Revue Générale des Sciences.

FOR some time the peculiar properties of certain alloys of nickel and steel have attracted much attention, their behavior, both as regards magnetic and thermal, differing widely from that of either of the constituents. Although these properties have been carefully studied and given certain practical applications, notably through the efforts of M. Guillaume, no definite theory to explain them has yet been framed. In an article in this magazine for October, 1901, M. Guillaume discussed some of the more important of the nickel-steel alloys, and now, in two important papers in the *Revue Générale des Sciences*, he further examines the experimental results which he has obtained in the course of his work at the International Bureau of Weights and Measures at Breteuil, near Paris, and shows how a theory may be outlined to accord with the observed facts.

Briefly, the alloys of nickel and steel, or of nickel and iron, may be divided into two groups, named by M. Guillaume as the reversible and the irreversible alloys. These two classes may best be described by referring to their relation to a peculiar property of a special alloy. Both iron and nickel, as is well known, are magnetic metals, that is, they are attracted by a magnet. Of the various alloys of the two metals, however, the one containing 25 per cent. of nickel, is non-magnetic, thus differing in this respect from both of its constituents. When this alloy is cooled it becomes magnetic, but when the original temperature is restored the magnetism disappears. Alloys containing less than 25 per cent. of nickel are magnetic, to a greater or less degree, and although this property disappears on heating, it returns upon cooling. When the nickel content exceed 25 per cent., the alloy becomes magnetic on cooling, but when heated the magnetism disappears and does not return upon subsequent cooling. There are a number of minor peculiarities about these various alloys, but in general they may be divided into reversible and irreversible alloys, that is, those in which the magnetic properties come and go upon cooling and heating, and those in which the property does not return when the metal is cooled. These distinctions are not strictly complete, but will serve to indicate the classification according to magnetic properties.

The thermal properties are also both curious and contradictory. Both iron and nickel follow the ordinary laws of expansion and contraction, increasing in volume when heated and diminishing when cooled, each having its own coefficient of expansion, and being fairly uniform in this respect. The alloys, however, show a curious variation from these usual conditions. The alloys containing a small percentage of nickel have practically the same coefficient of expansion as iron, but above 25 per cent. of nickel the coefficient rapidly diminishes, until, when the proportion of 36 per cent. of nickel to 64 per cent. of iron is reached, the coefficient of expansion has fallen to such a low value as to be almost inappreciable, being only about one-tenth of that of platinum. This alloy has been given the name of *invar*, presumably because of its invariability under temperature changes, and it has already found important practical applications in the form of measuring tapes and wires for geodetic work, and for the suspension rods for pendulums for clocks, as well as for minor standards of length. For alloys of a higher nickel content than 36 per cent., the expansion coefficient again rises, until it approaches that of nickel, or nearly that of iron. In the course of this range of variation, it is possible to find a combination which has practically the same coefficient as glass, this furnishing a material capable of replacing the more costly platinum for fusing in glass connections where other metals are inapplicable.

In addition to the peculiarities in respect of magnetic and thermal properties, exhibited by the various nickel-steel alloys, similar effects are found when the elasticity is examined. The irreversible alloys show, for a lowered temperature, an irreversible diminution in the modulus of elasticity, contrary to the normal phenomena, while the reversible alloys show a reversible diminution in the modulus.

The explanation of these various peculiarities is not easy, and no fully acceptable theory has yet been found. M. Guillaume, however, seeks to discover it in the behavior of the two states of the iron in the combinations. It has been demonstrated by various investigators that iron undergoes certain physical changes during heating and cooling; and the phenomena of recalescence, and of the changes from the *beta* to the *gamma* states, are well known. The coefficient of expansion of iron is expressed by a formula containing two terms, and the second of these indicates an important action under the influence of heat. Thus the coefficient of expansion remains practically uniform until a temperature of about 900° C.

has been reached, when for a short period a contraction occurs, after which the expansion proceeds again uniformly. Nickel, on the contrary, shows no such action, the expansion coefficient continuing practically uniform. Now, according to the theory of M. Guillaume, the influence of nickel, when alloyed with iron, is to cause these peculiarities of the iron to become apparent at much lower temperatures than is the case with the pure metal. In other words, according to M. Guillaume, the addition of nickel transports the changes in the state of iron under heat into the region of ordinary temperatures, thus enabling the phenomena to be observed with ease, and permitting them to be utilized.

The details of the theory, together with numerous diagrams and data concerning the behavior of the two metals and their alloys, are given at length in the papers to which reference has already been made, and the whole series of researches on which they are based forms an admirable example of painstaking study and investigation. Apart from their importance in the industrial arts they form a contribution to the science of metallurgical physics which must be considered as one of the most striking of recent times.

POSSIBLE ECONOMIES IN ELECTRIC LIGHTING.

PRESENT AND PROBABLE IMPROVEMENTS IN LAMPS, EQUIPMENT, MANIPULATION AND METHODS.

W. A. Chamen.—Municipal Electrical Association.

THE competition which is constantly going on between the various methods of artificial illumination is fruitful in the production of improvements and atempts at improvements which represent, on the whole, a continual advance both in the character of the light produced and in the cost of its production. Both of the elements form the subject of a paper presented before the Incorporated Municipal Electrical Association by Mr. W. A. Chamen, from which we make some abstracts indicating the general trend of present effort.

Taking up first the ordinary incandescent lamp, Mr. Chamen asks:

"Is there any probability that the carbon filament is capable of being worked, with satisfaction as to its lasting properties, at any materially higher efficiency than the 3½ to 4½ watts per candle-power to which we are accustomed? The outlook in this direction does not seem very encouraging, though some 8 c. p. 250-volt lamps recently tested in Glasgow have started with an efficiency of 3½ watts per candle, while, after 600 hours of burning, the efficiency has not gone below 4½ watts per candle, thus showing that this degree of efficiency is not confined to lamps of 16 c. p. or over. Some 12 months or more ago an incandescent lamp bearing the name of "Crawford-Voelker" was brought out, having a filament alleged to be made of some carbide and promising considerable improvement in efficiency as well as long life. As, however, nothing has been heard of this lamp for some time, it must be assumed that some difficulties have arisen in its manufacture which have so far prevented its coming into market."

Leaving the filament lamp out of further discussion, the Nernst lamp, with its glower exposed to the air, is next considered, and in view of the extensive experience which has already been had with it during the past year it must be considered as fairly beyond the experimental stage.

"The results of recent experience from several different sources show that an everage life of 600 hours is by no means too much to expect, and doubtless this figure will be improved upon as time goes on. As regards economy, the claim put forward is that, light for light, the Nernst lamp consumes about half the energy consumed by the ordinary carbon filament incandescent lamp. Assuming the useful life of the latter to be about 800 hours, and that, roughly, eight lamps of 16 c. p. will give as much light as one 1-ampere 250-volt Nernst lamp, it will be seen that at an efficiency of 4 watts per candle some 409 units will be consumed by eight ordinary 16 c. p. lamps in 800 hours, the cost of which, at, say, 4d. per unit, equals about £6. 16s., to which must be added the cost of renewals—viz., eight lamps at, say, 1s. each=8s. or a total of £7. 4s. With the Nernst lamp the cost of energy will be about £3. 8s., to which must be added the cost of renewals or, say, one and one-third times 3s. 6d. (if we include the resistance as well), say, 4s. 8d., a total of £3. 12s. 8d., being a saving of £3. 11s. 4d., or nearly 50 per cent. This is a good margin to allow for even more frequent renewals of Nernst filaments, &c., and the average Glasgow consumer has not been slow to grasp the point, particularly in business premises where the charge for energy is 6d. per unit for the first 365 hours' use of maximum demand, and 1d. per unit for all further quantity. The fact that the filament requires heating before it will conduct the current, an operation requiring about half a minute, is against the Nernst lamp to some extent, but in many cases it is of no real consequence."

As a suggestion in connection with the improvement of lamps of this kind, Mr. Chamen remarks that as substances are known which will give off a brilliant light when heated to a moderate extent, there appears to be no apparent reason why some combination of carbon filament with some one of these materials might not be made which would unite the advantage of instantaneous lighting with that of high efficiency. Various attempts are now being made to produce lamps of this sort, but nothing practical has as yet been evolved.

Another line along which material progress has been made is seen in lamps using incandescent vapour as the illuminating medium. Of these the principal is the Cooper-Hewitt mercury-vapour lamp, concerning which much has been written, although but a limited number of the lamps has been made.

"It consists of a glass tube about 1in. in diameter and some 3ft, or 4ft. long, having a bulb at the bottom containing mercury and an iron electrode at the top. The tube is hermetically sealed and the air is exhausted to a considerable degree. The electric current is passed through the tube from the electrode at the top, which is connected to the positive pole of the circuit, to the mercury in the bottom. The working pressure for a tube some 3ft. or 4ft. in length is about 100 volts, but a much higher pressure is required to start it. This is produced by the insertion of a simple self-induction coil connected in the lamp circuit and coupled up with a switch in such a way that the tube can be momentarily short-circuited, thus putting the coil direct on to 100 volts pressure. On breaking this switch the kick or extra E.M.F. produced by the coil forces a passage through the tube, starting the mercury into vapour, and immediately a steady current commences to flow. The light at first is tinged with purple, but as the tube warms up it becomes whiter. The peculiarity of the light itself is that there are no red rays in it, and its effect upon the beauty of a rosy complexion is disastrous. This cannot, of course, be set right by making the tube of red glass. A plate of red glass, which will let through floods of red light from a ray of sunshine, acts almost like a total eclipse when applied to the Hewitt lamp."

Various improvements have been made in the arc lamp since its first practical introduction for general lighting. Among these may be mentioned the enclosed arc, enabling lamps of lower candlepower and longer life to be made than was possible with the older form with exposed carbons. This has come into extensive use and must be considered as a real improvement. Another method of increasing the efficiency of the arc is the mixing of various substances with the carbon, usually barium, calcium, or strontium compounds, these enabling a much longer arc to be maintained, and filling the space between the carbons with incandescent material. This method has enabled the efficiency of the arc to be nearly doubled.

"There are, however, still some objections and difficulties to be overcome before this type of lamp can come into general use for street lighting. Firstly, the consumption of carbon is very much greater than with the ordinary type of arc lamp, thus necessitating trimming at more frequent intervals. Secondly, the light is not so steady as that of the ordinary arc, having a continual quiver rather like a badly-burning gas flame. Thirdly, it does not seem to have been possible so far to produce a satisfactory burning lamp which will give the same candlepower as the present 10-ampere lamp with a consumption of only half the energy. All that has been brought about seems to be the doubling of the light without altering the present consumption of energy, and this is hardly what is required in ordinary street lighting. The light given by an ordinary open arc of 10 amperes (which one may take as being in round figures 1,000 c. p.) is a sufficiently large unit for almost any class of street lighting, and in many cases a 7½-ampere lamp is ample for the purpose. One cannot but feel, however, that all these difficulties will, in one way or another, disappear as time goes on and as various further improvements are developed.

Apart from improvements in the lamps themselves there are possible gains to be made in handling and manipulation. Thus the duration of burning, when properly used may enable a considerable economy to be effected in trimming and attendance. The use of double-carbon lamps of 38 to 40 hours running makes it possible to trim the lamps every alternate day, thus doubling the number of lamps which can be put under the charge of one trimmer and his helper, while with the 60-hour enclosed arc lamps the two men can care for three times as many lamps with the same amount of labor, an important economy being thus effected.

In general, therefore the possible economies in electrical illumination do not yet appear to be exhausted, and it is possible that by increased efficiency and decreased attendance costs there may be very material reduction effected, especially in connection with street lighting.

PETROLEUM MOTORS FOR MARINE USE.

APPLICATIONS OF INTERNAL-COMBUSTION MOTORS ON VESSELS FOR AUXILIARY PURPOSES AND FOR PROPULSION.

A. Bochet—Société des Ingénieurs Civils de France.

IN comparison with the remarkable increase in the use of internal-combustion motors for driving automobile vehicles on land their applicability for marine service has, to a large extent, been overlooked. A number of small launches have been equipped with naphtha or gasoline motors, but these have usually been small boats intended for intermittent service and regarded rather as toys than as permanent installations of motive power.

In a paper recently presented before the *Société des Ingénieurs Civils de France,* and published in the *Mémoires* of the Society, M. A. Bochet discussed the more important applications of internal-combustion motors to marine purposes, and the examples given by him show very effectively the extent to which such motors have been seriously considered for such service.

M. Bochet considers only such motors as operate with heavy petroleum, the machines using gasoline or essence being considered unsuitable, both because of the operative cost and by reason of the danger from fire. Of these motors, by far the greater number in use on shipboard are employed for auxiliary purposes, and for sailing vessels, in which there would otherwise be no available source of power, they have been und of great value. Thus, petroleum mo- have been applied for the driving of dynamos for electric lighting, enabling sailing vessels to be provided with electric search lights as well as incandescent lights for general interior illumination, and experience has shown that motors for this purpose are as reliable and steady under the varying conditions of weather and motion as are steam-driven generating sets.

For modern large sailing vessels, in which the great economy of transport is assured, and in which it is desired to operate with as small a crew as can be practically employed, the use of auxiliary machinery for handling the sails has become well established. In most instances a small steam plant is installed and a number of winding engines and other auxiliary machinery disposed independently about the vessel. The low economy of such an arrangement is apparent, and the intermittent character of the service, together with the necessity for prompt and effective operation in cases of emergency renders the internal-combustion motor especially well adapted to the work. Each petroleum motor may be placed in the most desirable location, independently of the others, and the absence of any boiler or pipe connections simplifies the arrangement very materially.

The use of petroleum motors for propelling purposes is limited by the size of the machines at present constructed, these rarely exceeding 200 or 300 horse-power, but as auxiliaries to sail power they may be most effectively applied. M. Bochet cites a number of instances on the Swiss lakes, notably on the Lake of Constance, in which auxiliary motors have been installed with much success. At first the sailors were timid about placing any great dependence in the motors, believeing that they would prove unreliable, but with increasing experience the popularity of the machines has rapidly extended, and at the present time nearly all the commercial sail boats on the lake are equipped with motors, ranging from 6 to 18-horse-power, and rendering them independent of calms or adverse weather. At the present time there are 42 sail boats on the Lake of Constance which are provided with auxiliary petroleum motors, and the volume of merchandise transported has quadrupled since their introduction, owing to the greater reliability of the service. Boats of 80 to 90 tons displacement are propelled at a speed of about 12 kilometres an hour by motors of 18-horse-power.

Another service in which auxiliary motors have been applied with success is found among the fishing boats off the French coast. The addition of a small motor and propeller to the sail power renders such boats independent of adverse weather conditions and permits them to reach and return from the fishing grounds with the least loss of time. As the motor can readily be started when wanted it is used only when the wind fails, but in such cases the possession of even a small amount of motive power becomes of the greatest service. M. Bochet illustrates the equipment of a 53-ton fishing boat in which a 20-horse-power motor, fitted with a compressed air starting device supplies ample power, the manœuvering being effected by the use of a propeller with reversible blades.

It is very desirable that motors for use on boats or vessels should produce as little vibration as possible, and many of the single cylinder machines operating upon the Otto cycle are unsuited for the purpose. By using several cylinders the turning moment may be made nearly uniform and the reciprocating parts so disposed as to balance each other, but this leads to more complication than is desirable for small motors, and M. Buchet shows a design of a motor made by MM. Sautter-Harlé & Cie., in which the explosion occurs between two pistons moving in opposite directions, giving a complete balance with a simple arrangement of parts. By combining such a motor with a spring suspension all vibration is prevented from being transmited to the vessel, and the presence of the motor is not appreciably felt.

The most interesting application of an internal-combustion motor to marine propulsion which has yet been made is that of the Diesel motor, of which a special machine of 20-horse-power has been designed and installed upon a boat in active service upon the Rhine-Marne canal. The high economy and effective performance of this motor in stationary service should render it equally effective for use upon vessels, and it is altogether possible that it may become extensively applied as a source of marine motive power.

EXPERIMENTS ON AIR RESISTANCE.

RESULTS OF INVESTIGATIONS UPON THE RESISTANCE OF THE AIR TO THE MOVEMENT OF FALLING BODIES AT THE EIFFEL TOWER.

M. G. Eiffel—Comptes Rendus.

NUMEROUS experiments have been made to determine the resistance which the air opposes to a moving surface, but the results have been rather discordant. In view of the meagreness of reliable working data available, the paper presented to the French Academy by M. G. Eiffel, the well-known engineer, and published in a recent issue of *Comptes Rendus*, is of value and interest. This communication contains a resumé of the results of experiments conducted by MM. Cailletet and Colardeau upon the resistance opposed by the air to the movement of bodies allowed to drop from the second platform of the Eiffel tower at Paris, and the care with which these trials were conducted, as well as the extensive scale of the experiments adds to their technical importance.

The important question, from an engineering point of view, is the determination of the manner in which the pressure of the wind acts upon stationary bodies, and the action upon concave, convex, and inclined surfaces is at the present time far from being definitely understood. It is, however, accepted that the resistance of the air to a moving body is not greatly different from the pressure of wind moving at the same velocity, and under similar conditions against a fixed body, and hence experiments like those undertaken at the Eiffel tower possess a direct practical value.

It has been fairly well demonstrated that for velocities below 50 metres per second, or about 10,000 feet per minute, the pressure is proportional to the square of the velocity. If it is assumed that the pressure is directly proportional to the surface upon which it acts, we have as a simple expression of the pressure of the wind upon any surface:

$$P = K S V^2,$$

in which S, is the area of the surface; V, the velocity of the wind, and K, a constant to be determined by experiment. In general practice this constant K is taken as equal to 0.125 kilogrammes, so that a wind of 1 metre per second would exert a pressure of one-eighth of a kilogramme upon a surface of one square metre area.

When it is attempted to apply this rule to various cases, however, it is found that the results are often far too high, so that either errors have been made in determining the velocities, or else the coefficient K, has been taken too large. Professor Langley, in the course of his investigations, has reduced the value of K to 0.08, or about two-thirds of the above. Nearly all such experiments, however, have included the use of the Robinson anemometer for the measurement of the wind velocity, and the difficulties involved in the calibration of instruments of this type make it desirable that some more precise method be used.

The apparatus employed in the experiments at the Eiffel tower consisted of a flat plate, weighted to about 120 kilogrammes, and falling freely with as little resistance as possible. It was guided by a vertical cable and carried the recording apparatus with it, this apparatus consisting of a pulley, rolling upon the guide cable, and operating the recording drum; a tuning fork, indicating by its vibrations the time intervals; and a spring dynamometer connection between the surface plate and the carriage, to enable the pressure at every point of the course to be recorded. Since the actual velocity was recorded at all times, the retarding effects of frictional resistances were eliminated.

Experiments were made from two heights, one of 90 metres and the other of 45 metres, while three sets of plates of various forms were used, these having relative areas of 1, 2, and 4; and all of them exposing a surface at right angles to the direction of motion.

The general results are tabulated in the paper of M. Eiffel, to which reference must be made, but the important points are here briefly given. In the first place, it is shown that the coefficient K is not a constant, but varies with the surface, being greater for larger plates than for smaller ones. The variation appears to depend, not directly upon the areas of the surfaces, but upon their perimeters, a relation already indicated by the experiments of Hagen and others. Within the limits of the experiments made at the Eiffel tower, the value of the coefficient K is closely given by the relation:

$$K = 0.032 + 0.022\, p,$$

in which p is the perimeter of the surface under consideration. The mean value of K, for a circular plate of 0.30 metre in diameter, moving at a velocity of 40 metres per second, is 0.054, which is much lower than any of the values hitherto employed in practice. For a square plate of one-tenth of a square metre in surface, the coefficient by the formula is 0.06, or only about one-half the value in common use. The value of this coefficient, as given by D'Aubuisson, is 0.113; the formula of Hagen gives 0.085, which is the same as is given by Dines; Professor Langley uses 0.08; while the experimental results of Cailletet and Colardeau give 0.07.

So far, the experiments have been made only upon flat surfaces, moving in a direction normal to the pressure, but it is proposed to continue the trials with surfaces of various shapes and in different positions, and there is little doubt that valuable additions will be made to the store of data relating to this important subject.

It has long been realized that the present methods of computing the resistance of structures exposed to wind action are unsatisfactory, and some eminent engineers have asserted that much unnecessary expense has been incurred in providing for stresses which never occur in fact. Much of the uncertainty which attends the question is due to the generalization from experiments made upon a small scale or under special conditions, and it is only by the use of apparatus and methods reproducing within reasonable limits the actual conditions that reliable working data can be expected. The experiments of MM. Cailletet and Colardeau are a step in the right direction, and should give useful information concerning the direct pressure of the wind acting with a uniform velocity, and when extended to surfaces other than plane and normal to the direction of pressure they will be of great value. At the same time the most serious effects of the wind upon resisting structures are caused by the action of sudden gusts and violent puffs, the true force of which it is most difficult to determine, and which it is almost impossible to reproduce in an experimental manner. In this respect the action of the wind is similar to other shocks and impact effects which can only be covered by a margin of safety which has been found sufficient in established practice.

It is possible that the force of such gusts might be determined, after a time, by the erection of structures of a determinate surface and resistance, these being placed in exposed situations and allowed to remain until destroyed by the wind. By making a series of such structures of various resistances the margins of safety existing between those wrecked and those remaining might at least establish limits between which the mean of safety and economy would be found. The elements of uncertainty in all such determinations forbid too close dependence upon results claiming a high degree of precision, but it is at least some evidence of progress to see such determinations as those described by M. Eiffel.

MINERAL RESOURCES OF THE UNITED STATES.

A REVIEW OF THE NATIONAL MINERAL WEALTH AND THE CONDITIONS OF ITS COMMERCIAL DEVELOPMENT.

Charles Kirchhoff—National Geographic Society.

IN the course of an address delivered before the National Geographic Society, Mr. Charles Kirchhoff reviewed the mineral resources of the United States in a manner which gave a very complete idea of the extent of the national wealth in this department, and some abstract of his paper is here given. Even with the large study which has been given to this important subject it is not yet possible to speak with precision of any country, since new discoveries are being made from time to time in all lands, while in the United States especially the extent of the country and the difficulties of exploration of many portions render it impossible to do more than discuss present operations and indicate the future lines of development.

Mr. Kirchhoff takes the one case of coal, however, and makes a rough estimate of the resources of the United States in comparison with other countries, and his figures are interesting. Of an estimated coal area of about 4,650,000 square miles in the world, China is credited with 4,000,000 square miles! The United States has about 280,000 square miles; Great Britain, 11,900 miles; Germany, 1,770 miles; France, 2,086 miles, and Belgium, 510 square miles. It is not safe however, to compare the values of these figures directly, since area is not a true measure of value. The anthracite fields of Pennsylvania include an area of only 468 square miles, but these are undoubtedly of more value than any coal area of like extent anywhere in the world. Passing from coal to other mineral products, Mr. Kirchhoff gives a resumé of the geographical location of the important minerals and a brief historical review of their development, showing that it was not until the latter half of the nineteenth century that enterprise was seriously turned to the mining industry, and that its greatest achievements in the United States have been crowded into the past thirty years.

Reviewing the growth during the past twenty years, it is shown that the value of the mineral product of the United States had risen to about $370,000,000 in 1880, reached $620,000,000 in 1890, and, according to the statistics collected by Dr. David T. Day, of the United States Geological Survey, exceeded $1,000,000,000 in 1901.

"This includes $350,000,000 for coal, $242,000,000 for pig iron, $87,000,000 for copper, $78,000,000 for gold, $66,000,000 for petroleum, $55,000,000 for stone, $33,000,000, commercial value, for silver, $27,000,000 for natural gas, and $23,000,000 for lead.

"We stand first as producers of coal, our output in 1901 having been 263,000,000 long tons, Great Britain following with 220,000,000 tons, and Germany with 153,000,000 tons, our percentage of the world's total being about 31 per cent. In petroleum we have been racing with Russia, occasionally first and sometimes second. In 1901 we furnished a little over 69,000,000 barrels to the world's total of 165,000,000 barrels, our percentage being 41.9 per cent. as compared with Russia's 41.5 per cent.

"In the manufacture of pig iron we have now reached the point that our production is greater than that of our largest rivals, Great Britain and Germany, put together, with Belgium thrown in. We manufactured in 1902 fully 40 per cent. of the world's total.

"The gold production of the world was about $265,000,000 in 1901, to which we contributed $80,000.000 and Australasia $77,000,000. Of course, when the Rand resumes its full production and again starts on its natural increase, we shall probably have to yield first place to it.

"The world's production of silver has a commercial value of about $103,000,000. Here again we occupy the first rank, with Mexico as a close second.

"The supremacy in the copper mining industry is undoubtedly ours for many years to come. In 1901 we produced over 52 per cent. of the total of the world's yield of 512,000 tons. In that year, with a product of 269,000 tons, we came close to the entire world's output in 1890, when it was 273,000 tons."

In the midst of such a mass of mineral wealth it is doubtless true that abuses have accompanied their development, and that in many instances the principle that it pays to waste has been deliberately followed.

"Within certain limits that may be economically justifiable. In a new country, without adequate transportation facilities, high labor, and difficult surroundings, it is possible only to select the best and the richest, but unfortunately in mining that process of selection in most cases practically renders unavailable for the future that which has been rejected. Much of it is forever lost to the world, and what can be saved at a later date can be recovered only at a greatly increased cost. In the early days of our mining we have been unskillful, and even to-day we are robbing nature's storehouses of treasure, often destroying more than we utilize. At one time, not so many years since, barely one-third of the anthracite coal in our beds finally reached the consumer. The other two-thirds were lost in mining and in preparation for market."

An important feature in connection with the development of the mineral resources of the United States is the question of their control by powerful monopolistic combinations of capital. Although this contingency might seem remote in view of the magnitude of the mineral resources, yet a closer examination of the conditions gives it a somewhat different aspect.

"The conditions affecting the industrial utilization of mineral property vary greatly, and a closer study reveals the fact that a relatively small number of the deposits, through favoring circumstances, give their possessors special advantages. The deposits may be exceptionally rich or extensive, particularly pure, or may be so located with reference to the markets that they are capable of yielding an adequate supply at a cost far below others. These advantages may represent enormous sums, and can therefore be capitalized correspondingly. Unless those who control them extort undue returns, measured by earning capacity, the owners of the other less favorably located deposits cannot compete and live. Of course, the risk is always run by those who secure control of the best of the mines that new deposits as valuable may be discovered elsewhere, just as those who utilize monopolies based upon patents take the chance that inventive genius, stimulated by opportunity, made exceptionally artificial, find means to dispute exclusive possession. There may be iron ore deposits as rich and as great as any on the Lake Superior ranges in the Rock Mountain region, yet for a generation to come they might as well be non-existent, so far as the controlling position of the United States Steel Corporation is concerned. An enormous power for good or for evil may be wielded by groups of capitalists who control the commercially available mineral resources, though they constitute only a small fraction of the total assets of mineral wealth of the country. The fact that in most cases the earning capacity of these consolidations has been rated exceedingly high furnishes a premium on the development of hitherto neglected deposits, and thus constitutes the greatest source of danger to the stability of many of these giant undertakings. What is perhaps to be most deplored is that these organizations, on their present basis, impose upon the industries dependent upon them a burden of fixed charges which must handicap this country in its struggle for an increasing share in the world's markets."

ECONOMY OF FUEL IN POWER STATIONS.

ADVANTAGES AND LOSSES IN THE USE OF CONDENSATION IN CONNECTION WITH STEAM MACHINERY.

Henry MacLaren.—Institution of Mechanical Engineers.

AMONG the papers presented at the recent meeting of the Institution of Mechanical Engineers one which attracted much discussion was an examination of the economy of fuel in electric generating stations, with especial reference to the question of the value of the condenser as a means of saving fuel. The author of the paper, Mr. Henry MacLaren, stated in the beginning that he had taken his data from the tables of costs published weekly in the *Electrical Times,* these again being based upon the returns made by the various public and municipal lighting authorities to the Board of Trade. Referring especially to the returns for the year ending with the close of March, 1902, Mr. MacLaren recalls the fact that this was a period of exceptionally dear coal, and goes on to state the following points, in connection with [illegible]:

"The first point that attracts attention is the great difference in cost per unit generated in these stations. They are located in various parts of the country; some are condensing, others partly condensing or non-condensing stations, the price paid for coal varies largely, and different systems of supply are used. All these considerations affect the costs.

"In the returns for the lighting stations, the figures are based on units sold to consumers, and therefore include the large leakage or loss in the mains, which is debited to the generating plant. This may be as much as 20 per cent., and is a very important factor to be kept in mind when comparing purely lighting stations with tramway or railway plants, that "meter" the current as it leaves the station.

"Engineers would naturally expect that condensing stations would show a better fuel economy than non-condensing, both for tram and lighting purposes, but so far as lighting only is concerned it is just the reverse; the [illegible] both in fuel and works costs [illegible] considerably in favor of non-condensing stations. Where trams are added [illegible] lighting, the condensing plants show a better economy than non-condensing, but in all cases the partly condensing station is the most economical, both in fuel and works cost.

"Works costs include fuel, oil, water, waste, stores, wages of workmen, repairs, and maintenance. It is manifestly unfair to compare purely lighting stations, which have only a poor load factor, with stations that combine lighting and tramways, and generate large quantities of current all day long, and meter it as it leaves the station."

Subdividing the various stations under consideration into groups which may be considered fairly comparable, Mr. MacLaren finds that for 22 stations supplying light only, the cost in pence, per kilowatt-hour, (Board of Trade Unit) was, for non-condensing plants, 1,007, while for partly condensing stations it was 0.972, and for condensing stations 1.169 pence. The proportion of works-costs was about the same, being 1.632 pence for the non-condensing stations, 1.576 for the partly condensing plants, and 1.999 pence for the full condensing stations. Comparisons of provincial lighting stations give similar figures, the condensing stations in both cases giving the higher costs, both for fuel and for works costs. In the case of provincial stations supplying current both for lighting and for tramways the advantage appears on the side of the condensing stations, although the partly condensing plants show a better efficiency than either of the others.

Since it is well understood that the condensation of the exhaust steam in itself should lead to a higher economy that when high pressure engines are used it is evident that the poor showing of the condensing plants must be due to causes, which, while connected in some way with the use of condensation, should not necessarily occur. Mr. MacLaren attributes the results largely to the use of separate central condensing plants, and shows the manner in which their use may lead to very wasteful operation.

"Separate condensing plants are used in most lighting stations. The vacuum in the main engine low-pressure cylinder is usually poor, owing to the long lengths of exhaust pipe, often overcharged, and having numerous sharp bends; 11 in. vacuum in the cylinder has been recorded with 23 in. in the condenser. Station engineers, as a rule, do not pay sufficient attention to this. The engines of separate condensing plants, and other auxiliary machinery, are often fitted with piston valves. Such engines may be fairly economical when new, but soon develop a great appetite for steam. They are usually fixed in inaccessible places out of sight and out of mind. Their inflated exhaust passes direct to the condenser unobserved. It is quite common to find this type using 10 per cent. of the steam required by the main engines, when working at their full load, this percentage increasing rapidly as the load falls off. A recent test of a separate condensing plant revealed the fact that it used 4 lb. of steam per unit generated by the main engines.

"Engines fitted with their own condensers have a great advantage over those exhausting into one main serving several engines, usually a saving of 5 to 10 per cent., due to the better vacuum, is effected. Add to this the 10 per cent. of steam used by the separate plant, the loss in the auxiliary steam main with its traps, the loss in starting up separate plants for short runs, the loss at light loads, the loss of vacuum through leaky atmospheric exhaust valves, and it is not so surprising that under these conditions the economy due to condensing reaches the vanishing point, or even falls 13 per cent. behind well-equipped non-condensing stations, as shown by the tables. The author's firm usually guarantee 7½ per cent. less steam per kilowatt-hour if the engines are to be fitted with their own condensers and drive their own pumps. The total cost of these engines is less than those fitted with separate condensers, and the steam required by the auxiliary machinery is altogether saved."

So far as the non-condensing stations are concerned, it appears that they beat the condensing stations by 13 per cent. in fuel economy, but this may fairly be attributed to the poor performance of the condensing plants rather than to any very high efficiency in the non-condensing engines. By using good exhaust feed-water heaters the performance of non-condensing plants may be very materially improved, especially if these are employed in connection with economizers placed in the chimney flue.

"The steam losses in electric generating engines are mostly due to valve or piston leakage—mainly the former. This applies more especially to condensing stations using engines fitted with piston valves; unless these are very carefully looked after, heavy leakage is likely to occur, the steam passing direct to the condenser. In non-condensing engines the exhaust pipe usually gives warning of leaky valves. Many station engineers do not appear to realize how serious this loss may be, and allow their piston-valves to run in a very leaky condition. Others give this matter most careful attention, [illegible] are well rewarded for their trouble. In fa some of the most economical non-conde stations are fitted throughout with pi valve engines, carefully looked after [illegible] kept steam-tight. Balanced [illegible] valves, and valves of the Corliss typ [illegible] me pressure on the back to keep [illegible] the port faces, require much less attention, and will run for many years practically steam-tight. Two recent tests of condensing engines—in different stations—fitted with piston valves, disclosed the fact that they required over 45 lb. and 50 lb. of steam per kilowatt-hour respectively. When previously tested the consumption was about 30 lb. per kilowatt in each case. Outwardly they appear to be running as well as ever. Coal to the value of £839,613 was used in the 177 stations given in the tables, during the year under review. It is safe to assume that £100,000 was lost in engine leakages alone. There is no doubt it would pay to employ an engineer in each of the larger stations to do nothing else but make tests and report on fuel losses, with a view to their remedy."

Examining the question of boiler performance, as bearing upon the general efficiency of a plant, Mr. MacLaren properly lays much stress upon the quality of steam furnished to the engines. Many of the popular water-tube boilers furnish very wet steam, not to be compared with the drier steam supplied by the older types of boilers having ample steam and water space, and operated at slower rates of combustion and evaporation. The fluctuating demands for steam also serve to render mechanical firing uncertain and often unsatisfactory, and in some cases the excessive volume of cold air which can enter gives a low flue temperature and renders this element worthless as a measure of boiler performance.

The economy in works-costs shown by the non-condensing plants may be partly explained by the fact that there is less capital invested in the simpler system, and the repairs are fewer. At the same time it is admitted that with well-designed condensing engines fitted with their own condensers the best results should be secured, and that much of the gain due to condensing is frittered away by the use of unsuitable plant and by careless management.

Taking all the points made by Mr. MacLaren into account, his paper appears to be not so much an arraignment of the condensing system as it is of the defective management which has appeared in its installation and use. There is no good reason why the system of a central condenser should not make for higher economy over that of a number of separate condensers and air pumps attached to each engine. When one-half of the vacuum in the condenser is lost between it and the cylinder, somebody and not something should be held responsible for the loss. Leaky pipe connections, together with inadequate proportions, mean poor design and general neglect, while the engineer who waits for his exhaust pipe to tell him that his engine valves are leaking should be relieved of the responsibility.

Doubtless it is true that a well-equipped condensing plant requires more and better attention than the simpler non-condensing station, but better things naturally require a higher class of attendance and should receive it as a matter of course. Mr. MacLaren's paper is a distinct indictment of the manner in which many important power stations are operated and neglected, and it is to those facts, rather than to the difference in type, that administrative attention should be directed.

STREMMATOGRAPH TESTS OF RAILS IN SERVICE.

DATA AND RESULTS OF TESTS MADE WITH THE STREMMATOGRAPH UPON PERMANENT WAY UNDER MOVING LOCOMOTIVES.

Dr. P. H. Dudley—American Society for Testing Materials.

MUCH of our present knowledge of the condition and durability of the permanent way of railways has ı acquired by a study of the behaviour ıe roadbed in actual service. In this the methods included in the so-called agraph car, used by Dr. Dudley, has í great service, while the use of hods has materially aided in this important branch of engineering research. In a recent paper before the American Society for Testing Materials, Dr. Dudley has given the results of investigations of the behavior of rails under the stresses produced by moving loads, these results having been obtained by the use of the stremmatograph, a device which records autographically upon a *phosphor*-bronze slide the distribution of the unit fibre strains in the base of the rail under the wheel base of the locomotive.

Experience has shown that the best results are obtained in a railroad structure when a flexible and elastic construction is obtained. "Thus the rails and cross-ties are depressed by the wheel loads in the ballast from ⅛ to ¼-in., under the present heavy locomotives and cars. The compression of the ballast and sub-grade forms one-third to one-fifth of the total amount of the temporary subsidence of the rail. The sub-grade is affected to a depth of 12 to 20 ft., according to its material, construction and stability. There is a characteristic "general depression " of the rails, cross-ties, ballast, and sub-grade produced by each type of locomotive or car, to carry and distribute the loads, with specific deflections in the rails under the wheel contacts.

"In our present tracks the rail section acts as a continuous girder, and resolves the forces due to the moving wheel loads into horizontal components of strain in the base and head of the rails, which is partly continued through the splice bars from one rail to the next, to carry and distribute the wheel loads. The web of the rail also carries shearing strains at the points of flexure. In the section of the rail the neutral surface is neither elongated nor shortened by the deflections in the resolution of the components of strain. In the head of the rail immediately under the wheel contact the metal is in compressive strain above the neutral surface, while below the metal is in tensile strain. A strain of one character above or below the neutral surface is balanced by an opposite one in the section. The examination of a Stremmatograph record of the unit fibre strains in the rails, shows that they are a series of alternating strains of tension and compression, as the wheel loads and their spacing move over that particular portion of the rail."

In Dr. Dudley's paper the results of tests with the Stremmatograph are tabulated in such a manner as to show their distribution as regards the various portions of the wheel base of a New York Central locomotive, and while the figures are only approximate, they furnish some very instructive information concerning the distribution of stresses.

"When it is running, owing to the undulations in the track, also to movements of the wheels in their pedestals, and the irregular application of steam to the driving wheels, it is impossible to expect results corresponding to its supposed static wheel loading. As stated, we have a flexible or elastic track, with looseness of the rails upon the cross-ties. This must first be reduced by the weight under the forward truck wheels, which at once modifies the effect of the calculated static wheel loads of the locomotive. If the tracks were inflexible, except for the strains in the rails to support the loads, then we should obtain unit fibre stresses corresponding to the supposed static wheel loading of the engine, except for the driving wheels.

"It will be instructive to observe that the unit fibre stresses per pound of load in the rails under the forward trucks, carrying about one-half of the weight per exle of the driving wheels, are within one-fifth as much as those under the drivers, even with their added effect of the expended tractive effort. In other words, by a subdivision of the total load of the engine, a part may be used to stiffen and strengthen, not only the superstructure, but the sub-grade, to carry and distribute the heavier driving wheel loads with less deformation than would be possible without the forward truck. In the ten and twelve-wheel types of engines, for slow speeds, even more favorable results are secured. In some tests under twelve-wheel engines, at 15 miles per hour, under the forward truck, the unit fibre stress per pound of load was one pound, which reduced to 0.7 of a pound for a total load of 140,000 lbs. on the four pairs of driving wheels."

Dr. Dudley emphasizes the important element which is played by the forward truck in the distribution of rail stresses.

"The 'general depression' of the rail started by the forward truck wheels is continued under the driving wheel to the rear portion of the rail, held down by the following wheels of the tender. With this principle of distributing the loads of the locomotive, the greater weights carried upon the driving wheels do not produce a proportional increase of stress incidental to the expenditure of their tractive effort and the load carried upon the driving wheels. The rail instead of forming a deep depression under the driving wheels, is retained in a more level and uniform height in the general depression than would be the case without the assistance of the weight upon the forward truck. In extending the same principle to larger types of locomotives, having more than two pairs of driving wheels, the effect of the distribution of the increased load of the locomotives upon stiff rails has been rendered exceedingly advantageous."

Such a study of the behavior of rails under their actual moving loads leads to valuable points to be followed in the general design of locomotives.

"For the most efficient distribution of the total load of the locomotive, the wheel base must have proper design so that the wheel spacings are not excessive. It is noticed often that the wheel spacing between the rear driving wheels and front truck wheels of the tender is so long that the rail is relieved nearly of strain under the locomotive. In such conditions, which may be observed on light rails, the engine forms a general depression, and the following tender also another depression. These are both greater than would be the case were the 'general depression' formed by the driving wheels continued to the wheels of the tender.

"The general idea that the span of the bending rail is in accordance with the tie spacing, is not confirmed. Owing to the looseness of the rails upon the cross-ties, the span of the bending rails is influenced by the wheel spacing of the locomotive, in distributing its load.

"As the stiffness of the rails has been increased, the axle loads have doubled, within the past decade. The distribution of heavy loads upon stiff rails can be made without undue injury to the track. With the increased axle load, the intensity of the pressure between the wheel tread and the head of the rail is increased. The only way to relieve this is by a slight increase in width of head, and provide for it with proper physical quantities in the metal."

ENGINEERING EDUCATION IN THE UNITED STATES.

A REVIEW OF THE PROGRESS OF THE PAST CENTURY IN THE DEVELOPMENT OF TECHNICAL EDUCATION IN AMERICA.

R. H. Fernald—Engineers' Club of St. Louis.

WHEN the present interest in technical education is taken into account, both in Great Britain and in the United States, it is a matter for congratulation that the growth of engineering education in the United States has been so fully set forth as is found in several recent publications. Among these we may note the paper presented by Mr. R. H. Fernald before the Engineers' Club of St. Louis, and published in the *Journal of the Association of Engineering Societies;* and some abstract of this is given here as forming an interesting contribution to a vital matter in national progress.

The earliest institution giving an engineering training in the United States was the United States Military Academy at West Point, but this was limited in its scope as being restricted to those only who were preparing for the government service. The University of Virginia, founded by Jefferson in 1818, was planned to have a school of technical philosophy as well as of manual training, but the first engineering school in the modern sense of the term was the Rensselaer Polytechnic Institute, at Troy, N. Y., which graduated the first class of civil engineers, not only in the United States, but in any English-speaking country, in the year 1840.

With the development of the country came an increased demand for engineering ability, and other educational institutions established technical schools. The Lawrence Scientific School, of Harvard University, the third to introduce the study of engineering, failed to realize its great opportunity, and is only now beginning to recover its lost ground. The Sheffield Scientific School of Yale University was established in 1847, but did little before 1859, and with the coming of the civil war all the technical institutions found their work much disturbed. At this time, however, came the important matter of the Land Grant Bill, by which a certain portion of the public lands was alloted to each State for educational purposes, and the principal result of this act was the founding and development of Cornell University, the State of New York, through the wise management of Mr. Cornell, realizing far greater benefit from this source than any of the others. In Boston the Massachusetts Institute of Technology, under the able administration of Professor Rogers, did much to raise the standard of technical education, while after the war the engineering school of the University of Michigan, and the School of Mines of Columbia University entered upon the field.

Mr. Fernald gives numerous statistics in his paper to show the growth of the various engineering courses in the different institutions, and these show in a very interesting manner the influence of general affairs upon the attendance and the classification. The entrance of electrical engineering into the field with the older branches of civil, mechanical, and mining engineering is noteworthy, showing as it does how readily the institutions which were properly organized could admit into their curriculum any new and important subject, while the steady growth of all departments of scientific education, and shown by curves in diagrammatic form, is clearly indicated.

Believing that the best criterion of the work of any institution is found in the subsequent career of its graduates, Mr. Fernald shows that to-day the technically educated man of ability is looked upon with favor in the business world. The very fact that he has had to apply himself more closely and finds his course of training more rigorous than in the older courses for corresponding training in law, medicine, or similar professions, has tended to place the work of the engineer upon a basis not only commanding respect, but making the profession a learned profession in the highest sense.

Speaking broadly of the existing technical and engineering schools of the United States, Mr. Fernald says:

"The results of the excellent work of these progressive institutions are readily seen in the great engineering feats of the past few years, in the growth and prosperity due to such achievements, in the accomplishments due to engineering training in our recent war, and one need only trace these results to their sources to be convinced that the engineering school of to-day is a powerful factor in a nation's civilization and development, as well as in the general progress of the world. For the men who are achieving these results are men whose earnestness of purpose and appreciation and respect for the laws governing existing conditions have been guided and strengthened by these institutions—institutions whose aim has been to develop serious thought, power to weigh facts, ability to probe the reasons and laws producing given conditions, a true respect for the opinions and judgment of others—a comprehension of facts and conditions as they exist to-day, and the power so to modify, improve or take advantage of these facts that new and better conditions and opportunities shall be open to him who enters the world to-morrow."

PORTABLE APPLICATIONS OF ACETYLENE.

THE USE OF SOLUTIONS OF ACETYLENE IN ACETONE FOR ILLUMINATING AND HEATING APPLIANCES.

A. Janet—Le Génie Civil.

WHEN the brilliant illuminating power of acetylene gas was first made public many predictions were made as to the great value which would follow from its applications for purposes of train lighting and similar service, the idea being to use the conveniently portable liquefied gas. The dangerous character of the liquid acetylene soon became apparent, however, and after several disastrous explosions the use of the liquefied gas was abandoned. At the present time the use of acetylene in train lighting is mainly limited to the enriching of oil gas and similar purposes, and the other uses of the gas have not developed as might have been expected.

Among the early propositions to use the gas in some more secure manner, the plan of MM. Claude & Hess to employ the property of acetone as a solvent for the gaseous acetylene appeared to offer possibilities, but until recently this ingenious plan has not been extensively employed. Now, however, it has been revived, and there is every reason to believe that it will come into use. From a paper by M. A. Janet, in a recent issue of *Le Génie Civil* we abstract some account of recent experiences in France with the dissolved acetylene, and the success which has there been attained should lead to numerous applications elsewhere.

The researches of MM. Claude & Hess demonstrated the following facts:

At ordinary pressures liquid acetone is capable of dissolving twenty-four times its own volume of acetylene, and this quantity increases in direct proportion to the pressure.

As acetone is an exothermic substance, while acetylene is endothermic, a balance is established between the emission and absorption of heat, and the system remains exothermic and therefore nonexplosive, unless the proposition of acetylene exceeds certain well-defined limits.

It is therefor practicable to store acetylene in vessels already filled with acetone, to a much greater degree than would otherwise follow from the law of Mariotte, and yet avoid any risk from possibility of explosions. The difference between acetylene liquefied by pressure and acetylene dissolved in acetone is similar to that between liquid carbonic acid and the carbonic acid dissolved in a carbonated water, as in the well-known siphons.

At the present time vessels containing solutions of acetylene are supplied commercially in France, and M. Janet discusses the methods of applying the gas so supplied for various technical purposes.

In order to avoid the formation of compressed acetylene gas in the upper portions of the cylinders, the suggestion of M. Le-Chatelier has been followed, and the receivers are filled entirely with a solid mass of porous substance, the voids of which constitute a system of capillary spaces in which explosions cannot be propagated. In steel cylinders thus filled with porous matter together with liquid acetone, it is possible, with a limiting pressure of 10 kilogrammes per square centimeter, to enclose 100 volumes of acetylene. When the outlet valve is opened there is a regular and continuous discharge of acetylene without the production of any void in the vessel. Such cylinders have now been in regular service for five or six years without the occurrence of any sort of accident, showing the entire safety of the system.

The applications of such vessels of stored acetylene are numerous, and some of them are described by M. Janet at length. Naturally the employment of the gas for train lighting is the first which suggests itself, and in such service especially the necessity of freedom from explosions is most essential. The safety of the dissolved acetylene for this purpose has been shown in various ways.

Last winter a station at St. Petersburg was destroyed by fire, and in the building were several cars containing cylinders of stored acetylene; and after the fire the cylinders were recovered intact. Similar examples have been observed on shipboard, the stored gas being recovered complete from disastrous fires, and no explosion having occurred.

M. Janet refers especially to the convenience of the dissolved acetylene for use with the acetylene-oxygen blowpipe, to which reference has already been made in these columns.

The idea of substituting acetylene for hydrogen in the blowpipe and thus obtaining a very high temperature for use in the arts, is by no means new, but various difficulties have appeared in the practical application of the idea. If the jet is so arranged that the acetylene becomes heated before reaching the point of combustion, the gas is decomposed into hydrogen and carbon, and a deposit of solid carbon forms upon the jet, tending to form a serious obstruction. Under such conditions the hydrogen alone burns, and an ordinary oxy-hydrogen blowpipe is obtained, the hydrogen being supplied by the expensive process of decomposing acetylene. In order to sesure the correct combustion the jets should be entirely separate, and the acetylene should be lighted first, with the production of a long yellowish-white smoky flame. The oxygen then being slowly turned on, produces a violent commotion in the flame, which gradually forms itself into two zones; one being highly luminous, concentrated at the base of the flame, while the other of a pale red, hardly visible, occupies the point. The supply of a very small additional proportion of oxygen completes the adjustment; the flame becomes almost silent, projecting a long, almost colorless flame at the base of which is a sort of pencil of fire. The long flame is the hydrogen set free from the acetylene, and burning in contact with the air, while the pencil of fire is the true oxy-acetylene jet, in which exists the most formidable elevation of temperature which has yet been artificially produced.

For all the purposes to which the oxy-blowpipe are already numerous, and will doubtless become greatly extended as experience is had in its use. All the metals used in the arts may be welded by its heat, without the employment of any intermediate material. Broken connections may be repaired and defective pieces mended. Electrical connections may be made with certainty that the conductivity has not been impaired, and everything which includes the fusion of definite areas may be effected with convenience and certainty.

For all the purposes to which the oxy-acetylene blowpipe are adapted the use of dissolved acetylene is applicable, and the essential element of portability, combined with perfect safety renders it the most satisfactory method of carrying one of the elements of the apparatus. Compressed oxygen is already available, and being in itself non-combustible and non-explosive, needs no modification to adapt it to the practical requirements of the workshop and the field, so that both of the materials required for the application of the new tool are to be had. Under such conditions there is every reason to believe that the new source of high temperatures will become a tool in general use, and will be found not only in the workshop, but also in the field, the shipyard, and the bridge site.

THE UTILISATION OF WASTES.

CAUSES OF SUCCESSES AND FAILURES IN THE COMMERCIAL RECOVERY OF VALUABLE PRODUCTS FROM MANUFACTURING RESIDUES.

Engineering.

It was Dr. Samuel Johnson, we believe, who first defined a weed as a plant whose value had not yet been found out. In like manner many products have been permitted to go to waste because their value was not known, and much of the skill of modern chemistry and technology has been devoted to the recovery of such by-products as have been found profitable of treatment.

In a recent paper in *Engineering* the subject of the utilization of wastes is discussed, and it is shown that some of the more promising schemes for the recovery of value from residues have failed from reasons which might well have been understood in advance. At the same time there have been notable examples of the production of great values from most unpromising material, so that the whole question is one which demands the combined skill of the scientist and the business man if mistakes on either hand are to be avoided.

It is not so very long ago that phosphorus in iron was considered a most serious defect, but with the advent of the basic steel process and the realisation of the value of basic slag as a fertilizer this point of view has been wholly reversed. Again a portion of the heat which passes off in the discharge gases of a blast furnace has been utilised for a long time for heating the blast and for steam making in connection with boiler installations, but it is only within the past few years that the possible utilisation of the whole gaseous output of a furnace directly in internal-combustion engines for the generation of power has been appreciated.

Of course a large number of by-product recovery processes are found in connection with the various chemical industries, and these lend themselves readily to such economies, especially as the necessary professional skill to devise the best methods is generally available. It is just here, however, that familiarity with the commercial side of the question becomes of importance. The scientific man may feel sure that he has devised a method for the recovery of a valuable waste product, while the manufacturer knows well that it is cheaper to allow the material to run to waste than it is to incur the expense involved in its recovery. Very often the first cost of installation of the necessary plant includes a fixed charge which will continue to remain fixed while the methods of manufacture may be so modified as to render the process useless. Changes are frequent in the chemical industries, and a product may yield a good profit one year and involve the manufacturer in a loss the next. Apart from the direct technical and commercial features of the question there are often collateral points to be considered. Among these the cost of transport and the influences of competition must be taken into account, since in some instances a by-product which may readily be recovered cannot be placed in the market to advantage for commercial reasons which do not at first appear to the engineer or the purely technical man.

The state of the market, and its possible vicissitudes should also be considered before any important waste-recovery project is undertaken.

"A few years ago, it was proved to be practicable and economical for india-rubber manufacturers to recover the naphtha used in bringing the rubber into solution. This year, however, owing to certain causes, solvent naphtha has been contracted for at a price less than half of that which used to be considered the normal price. Under the circumstances, it is not surprising that the makers of naphtha-recovery plants are not busy. In a good many cases chemicals are run to waste which cound be profitably recovered by the chemical manufacturer, were it not for the matter of freight. The cost of carriage on the liquor from dye-works, or calico-printing works, is quite prohibitive in most cases; and unless there is inclination and the necessary facilities for working them up on the spot, they are perforce allowed to run to waste.

"A by-product business which has now been largely given up on account of the reduced selling price of the material is that of the preparation of copperas, or sulphate of iron, from coal-measure pyrites. This body, which occurs in some coal seams to a considerable extent, has to be removed as far as possible from the coal, and when copperas sold at 60s. per ton, it was the regular thing to make it from the pyrites by oxidation. To some extent this is still carried on; but, as a rule, in the North of England, the process has been given up since the selling price of the product dropped to about half the above figure. Recovery processes, or methods for the utilisation of waste, will be adopted or, more correctly speaking, carried on, only as long as the current market quotations for the products enable them to be worked at a profit; and, though this seems to be merely the statement of a truism, it is necessary to emphasize it in order to explain away the great disparity observable between the number of processes worked out theoretically, and probably patented, and the number found in actual operation."

All these facts emphasize the importance of the joint operation of the chemist, the engineer, and the business man in the consideration of the installation of any important plant for the recovery of by-products on a large scale. Thus the engineer is perfectly convinced that all the gases from a furnace plant can be used for the generation of power in gas engines. Apart from the demands for power in connection with the blowing engines, hoisting machinery, and other power requirements of the furnace plant, however, there is no immediate demand for all the large amount of power thus capable of development. It is altogether possible to have the powerful gas engines thus supplied with fuel, arranged to generate electric current, but unless there is an immediate market for electricity supply in the vicinity of the furnaces, the costs of transmission to suitable localities must be taken into account, together with the commercial end of the disposal of the electrical energy, either for lighting or for power purposes. All this means that establishments already organized for the purpose of manufacturing iron shall add to this a new undertaking, namely that of generating and vending electrical energy, entering into competition with existing establishments and generally branching out into fields foreign to their present work. In many instances this may be warranted and profitable, but in others it may be so much of an experiment as to demand most careful investigation and a thorough balancing of conditions before a correct judgment can be rendered. The utilisation of wastes is all right, but it is important to make sure that there is a field for the use of the wastes before the mechanism for their saving is put into operation.

ENGINEERING AND CHEMISTRY.

THE INTERRELATION BETWEEN TWO KINDRED PROFESSIONS AND THE POSSIBILITIES RESULTING FROM THEIR HARMONIOUS CO-OPERATION.

Prof. W. Ostwald—Verein Deutscher Ingenieure.

At the recent convention of the *Verein Deutscher Ingenieure,* a notable feature of the meeting was an address by Professor Dr. Ostwald, the well-known chemist, upon the relations which exist, or should exist, between the two professions of engineering and chemistry. The address is published in full in a recent issue of the *Zeitschrift des Vereines Deutscher Ingenieure,* and some abstract is here given.

Referring in an introductory manner to the general influence of applied science upon the welfare of mankind, Dr. Ostwald showed that while the human race had existed and flourished for thousands of years without the benefits of science, yet the direct advantages of the progress of recent years upon human health, comfort, and wealth have been most marked. In this work all the different departments of science have had an active share, and many of the most important developments have been due to the united action of different branches.

Without enumerating a long list of subjects in which the work of the chemist has become allied with that of the engineer, we may note directly the progress which has been made in the employment of chemical methods in connection with the study of materials of construction, in the examination of ores and of metals, and in the verification of results of combinations. The relations of the recent science of electrochemistry to engineering in general are also to be noted, since to it we must look for much of the possible development of electrical engineering, including the improvement of the accumulator, and similar work.

An important portion of the work of the mechanical engineer bears a close relation to the science of chemistry, since the reactions involved in the scientific utilization of fuels are essentially of a chemical nature. Thus the efficient combustion of fuels, the prevention of smoke, the study of waste furnace gases, and the like, demand a knowledge of chemistry for their successful prosecution, and much of the progress which has been made in this work is due to the associated work of the chemist and the engineer.

It is in this line that still further progress is to be expected. The development of the heat engine as a source of motive power is generally understood to be along the line of the internal-combustion motor, and this requires a union of the application of the principles of thermodynamics and the chemistry of gas production. Dr. Ostwald especially discusses the importance of the use of the principles of theoretical chemistry in the design of gas producers for various fuels. Thus it is possible to use the low-grade brown coals and lignites, or even peat as a cheap fuel, producing gas suitable for application in the most efficient manner in large gas engines similar to those designed for the utilisation of blast-furnace gases. By employing properly designed gas-producers the fuel may be gasified at moderate temperatures with a minimum loss of heat and a maximum degree of efficiency.

The technical applications of water gas are also of great importance, both in connection with illumination and as a fuel for power and metallurgical purposes, and great improvements in its efficient generation have resulted from the application of correct chemical principles to the practical processes. With all of these processes come the associated operations for the recovery of valuable by-products, some of which often rank in commercial value nearly with the principal product of gas or of power.

All these elements unite to make the establishment of central gas producing stations most essential for the attainment of the highest commercial efficiency. In this way the cheapest solid fuels may be converted into the most convenient and efficient gaseous fuel, both for power generation and for heating purposes. The gas engines may be associated with the same central plant, and the energy electrically transmitted to the numerous points of application. All the by-products may also be recovered to the maximum advantage and delivered to the accompanying chemical works. Included in the gas generating plant should be an installation for the fixation of the nitrogen contained in the gas and its reduction to the forms required for agriculture as fertilisers. The process due to Dr. Ostwald himself enables the gas-tar ammonia to be converted into ammonium nitrate, thus furnishing a richer fertiliser than is found in sodium nitrate.

In connection with the discussion of the importance of the joint work of the chemist and the engineer, Dr. Ostwald made a contribution to the much discussed subject of technical education and its influence upon professional and commercial progress. In England as well as in America it is generally assumed that the technical education available in Germany is of the highest order, and that to this cause is due much of the rapid progress which she has made in applied science. Among German professional men, however, there is believed to be room for much improvement in educational methods. It is manifestly impracticable to unite the technical high schools with the universities, as the latter are at present constituted, and any radical change in the university system of Germany is not considered. At the same time it is not impossible that the technical high schools may become associated together in their work and thus each strengthen the other. That this desirable end may be attained it is important to encourage the development of technical and engineering laboratories, so that the work of the technical student may be directed towards independent investigation and study under the general guidance of his professors and instructors, and thus the methods of the technical school become assimilated to some extent to that of the university.

TANGENTIAL WATER WHEEL EFFICIENCIES.

AN EXPERIMENTAL INVESTIGATION INTO THE RELATIVE VALUES OF DIFFERENT BUCKET SHAPES FOR IMPACT WATER-WHEELS.

G. J. Henry—Pacific-Coast Electric Transmission Association.

IN designing water wheels of the impact type, of which the well-known Pelton wheel is a conspicuous example, the form of the bucket against which the jet of high-pressure water impinges has a most important influence upon the efficiency. Various theories have been developed for the solution of this problem, and numerous experiments have also been made. The latest series of experiments are those described in a paper presented before the Pacific Coast Electric Transmission Association by Mr. George J. Henry, Jr., and the results of his investigations are of sufficient importance as to be considered a valuable contribution to this department of hydraulic engineering.

In the first place Mr. Henry calls attention to the fact that while it is most important, the bucket shape is but one element of several which influence the efficiency of the machine.

"To obtain the best efficiencies it is necessary to have the proper pipe line, gate valves, nozzles, water wheels and buckets, wheel case, wheel pit and tail-race, and all of these parts must be properly designed for the particular conditions under which they are to operate, and all will vary with the head or pressure—the water quantity and the revolutions which the wheel is to make. Many a water wheel bucket has been overworked for years, and then charged up with losses that occur because of its being improperly worn, due to this overwork. Again, buckets are frequently charged up with all kinds of losses which are really due to something for which the bucket is not responsible. Pressure, or wheel diameter, or speed on a given wheel, cannot be varied radically without materially altering the efficiency. Many hydraulic plants are in operation and developing not over 65 per cent. between the flume and water wheel shaft where the *bucket* itself is capable of developing 90 per cent., and where a very inexpensive change could be made which would increase the gross efficiency very materially and cause a great saving in the water bills."

The bucket of an impact tangential water wheel is so shaped as to receive the stream centrally and divide it in such a manner as to discharge the water with the minimum resistance, the energy of the stream being transferred to a maximum degree to the wheel itself. The direction of the discharge is naturally governed to a great extent by the form of the bucket, and it was to investigate the effect of various forms of buckets that the experiments described by Mr. Henry were conducted. Accepting the view that the best possible bucket efficiency is obtained when the water jet is taken up on the bucket surface, and brought to rest as nearly as possible with the least loss of energy, Mr. Henry analyzes the necessary losses as made up of the following elements:

1. The discharge velocity with which the water leaves the bucket with respect to a point fixed in space. Note that this velocity will vary with every position of the discharge as bucket moves.

2. Air and surface friction inside the bucket.

3. Imprisoned water in the bucket.

4. Variation in the stream form, producing erratic conditions of impact and flow on the bucket surface.

5. That occasioned by the stream being displaced by the entering bucket.

6. Eddy currents in the buckets.

7. Water which does not give up all its energy to the bucket.

Apart from any experimental considerations, Mr. Henry first considers the points upon which the most efficient bucket may be designed, as follows:

"Given a certain stream of water at a given spouting velocity, it is advisable that this be taken upon the bucket surfaces of just enough buckets to catch every particle of water on the dividing wedges and turn it all on the curved surfaces, and discharge it at just enough velocity (and entirely in a direction at right angles to the entering stream axis) to clear the next following bucket. This resulting velocity will be the tangent of the discharge angle, multiplied by bucket velocity.

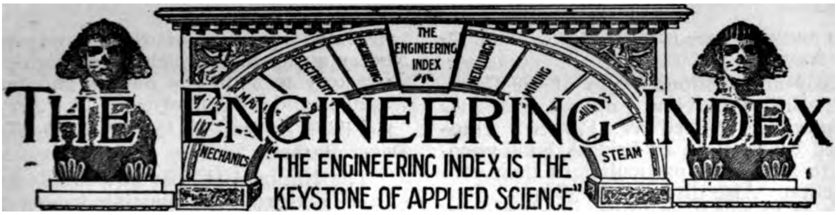
"The air and surface friction must be maintained as small as possible by the use of a nozzle which will give a perfectly circular and solid stream. The bucket surface and cutting edges must be of a shape which, with a minimum wetted surface, will allow the steam, without crowding at any point, to spread out in a thin fan-like discharge on each side. The surface must be such that the water will not adhere, and as smooth as possible.

"The surface may be ground and polished, or better, ground and well painted with a special compound. If all of these points are carefully studied out and the front of the bucket properly shaped and not cut away too low, the imprisoned water will not cause any appreciable loss.

"The windage will also be a minimum if the number and surface of the buckets is a minimum."

The experimental plant used by Mr. Henry included a wheel with removable buckets, enclosed in a plate-glass case, and illuminated by an arc light in such a manner that the whole could be photographed while in action. The result is an exceeding interesting series of photographs, showing clearly the manner in which the jet is received and discharged under different conditions. With this was included a Prony brake for determining the power developed, and accessory measuring apparatus for determining the water consumption, so that all the elements for determining the efficiency of any particular arrangement were present, besides the opportunity of seizing the visual appearance of the jet and the discharge.

For the details of the results of the experiments with the different buckets tested reference must be had to the original paper, but the principal conclusion deduced from all the trials is one in which every thoughtful engineer will agree, namely, that it is impossible to get equally good results from a certain shape of bucket under all the various conditions of wheel and stream diameter and water pressure, but that to get the best efficiency a bucket must be designed for each set of conditions. Theoretical investigations, in which frictional resistances in the bucket, as well as air and other losses are neglected, must necessarily give results at variance with the conditions in actual practice in which all these resistances are necessarily included. The water wheel designer must take into account all the conditions there are, and cannot afford to neglect any element which goes to make up the total efficiency.


THE ENGINEERING INDEX
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THE ENGINEERING INDEX

The following pages form a DESCRIPTIVE index to the important articles of permanent value published currently in about two hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every article.

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(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
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The full text of any article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the journals indexed are given.

DIVISIONS OF THE ENGINEERING INDEX.

CIVIL ENGINEERING 123
ELECTRICAL ENGINEERING 128
GAS WORKS ENGINEERING 135
INDUSTRIAL ECONOMY 138
MARINE AND NAVAL ENGINEERING 139
MECHANICAL ENGINEERING 141
MINING AND METALLURGY 148
RAILWAY ENGINEERING 152
STREET AND ELECTRIC RAILWAYS 154

CIVIL ENGINEERING

BRIDGES.

Arch.

A Contribution to the Study of the Semicircular Arch (Beitrag zur Untersuchung des Halbkreisförmigen Bogenträgers). G. Ramisch. An investigation of the distribution of stresses for various loadings of a semicircular arch, hinged at the springings. 2000 w. Zeitschr d Oesterr Ing u Arch Ver—July 3, 1903. No. 57326 D.

Blackwell's Island, N. Y.

The Specifications for the Superstructure of the Blackwell's Island Bridge. Lengthy abstract of these specifications, without comment. 3300 w. Eng Rec—Aug. 22, 1903. No. 57531.

Bridge Terminal.

Proposed Brooklyn Bridge Terminal and City Offices. Henry F. Hornbostel. An illustrated general outline of extensive improvements planned, which will cost $50,000,000, when fully carried out. 1300 w. Archt & Build's Mag—Aug. 1903. No. 57096 C.

Cantilever.

Cantilever Bridge at Connel Ferry. Illustrated description of a bridge in Scotland having a clear span of 500 ft. Gives also an account of the construction work.

3300 w. Engng—July 31, 1903. No. 57126 A.

Early and Curious Types of the Cantilever Bridge in New England and New Brunswick. Alfred W. Parker. Illustrated descriptions of bridges built previous to 1870, with particulars of their construction. Also discussion. 3800 w. Jour Assn of Engng Socs—July, 1903. No. 57451 C.

The Wabash Bridge at Pittsburg. An illustrated description of the cantilever bridge over the Monongahela River, which completes the Wabash extension into Pittsburg. It has a truss span of 812 ft. between pier centers, and is designed to carry the heaviest loads. The steel eyebars used are the strongest ever made. 1300 w. R R Gaz—Aug. 14, 1903. No. 57267.

Highway.

The Great Miami River Highway Bridge, Dayton, Ohio. Illustrated description of a reinforced concrete arch bridge, 56½ ft. wide, and 588 ft. long. 1500 w. Eng Rec—Aug. 8, 1903. No. 57192.

Old Bridge.

Old Railway Bridge Over the River Gaundless. Illustration, with brief account of an old bridge in England, recently replaced by a modern structure. 600 w. Engng—Aug. 14, 1903. No. 57493 A.

Plattsmouth.

The Plattsmouth Bridge of the Burlington. An illustrated account of the rebuilding of this bridge across the Missouri River. 1000 w. R R Gaz—Aug. 7, 1903. No. 57162.

Suspension.

The New Manhattan Bridge. A discussion of the proposed change to wrought steel chains instead of steel wire cables. 1800 w. Engr, Lond—Aug. 14, 1903. No. 57498 A.

Viaduct.

Erection of Manhattan Valley Viaduct. An illustrated account of the erection of a three-track plate-girder structure, 2,174 feet long, with a maximum height of about 54 ft., for the N. Y. Rapid Transit R. R. 1700 w. Eng Rec—Aug. 8, 1903. No. 57190.

Widening.

The Widening of London Bridge. Harold J. Shepstone. Illustrated description of the widening of the foot-paths. The method is interesting on account of the conditions under which the work is carried on. 1200 w. Sci Am Sup—Aug. 1, 1903. No. 57052.

CANALS, RIVERS AND HARBORS.

Docks.

The Bush Docks in Brooklyn. An illustrated account of this terminal for ocean steamships, which seems highly satisfactory to both ship owners and freight agents, and all interested. 1800 w. Ry & Engng Rev—Aug. 15, 1903. No. 57247.

Dover Harbor.

The National Harbor at Dover. Archibald S. Hurd. An illustrated description of the construction of the greatest artificial harbor in the world. 3800 w. Cassier's Mag—Aug., 1903. No. 57284 B.

Electric Dredge.

See Electrical Engineering, Power Applications.

Lighthouse.

See Electrical Engineering, Illumination.

Ore Dock.

A Large Ore Dock at Escanaba, Mich.; Chicago & Northwestern Railway. An illustrated description of the new dock, No. 6, which takes the place of the old No. 2 dock. 1400 w. Eng News—July 30, 1903. No. 57041.

River Improvement.

Waterway Improvement on the Ohio. William Gilbert Irwin. An account of important improvements made and projected with a view to increasing its facilities as a commercial stream. 2000 w. Sci Am—Aug. 15, 1903. No. 57195.

Sea Wall.

The Failure of a Sea Wall and Its Reconstruction. Clarence T. Fernald. An illustrated account of the failure of the old wharf at East Cambridge and the construction of the new sea wall. General discussion. 2500 w. Jour Assn of Engng Socs—June, 1903. No. 57447 C.

Susquehanna.

The Navigation of the Susquehanna River, and the Beginnings of the Reading Railroad. Williard T. Block. Reviews the early attempts to navigate this river, and the disaster that led to the construction of a canal; and the first railroads of Pennsylvania. 1000 w. R R Gaz—Aug. 7, 1903. No. 57164.

Tides.

Large Ebb and Flow in Harbor. George H. Waring. An illustrated article explaining the advantage taken of the large ebb and flow of the tide in the harbor of St. John, N. B., Canada. 900 w. Marine Engng—Aug., 1903. No. 56891 C.

CONSTRUCTION.

Foundations.

Boston Foundations. Joseph R. Worcester. A discussion confined to ordinary structures not requiring excessively large foundations, considering the best way to pile, what loads it is safe to place on piles, what grade piles should be cut, how foundation piles should be capped. Map, and general discussion. Ill. 22000 w. Jour Assn of Engng Socs—June, 1903. No. 57445 C.

Concrete Foundations. R. P. King. Practical hints for builders of machinery foundations. Ill. 3000 w. Mach, N. Y.—Aug., 1903. No. 57078 C.

Foundations for the Elevated Structure of the Boston Elevated Railway. George A. Kimball. Illustrated detailed description. 1800 w. Jour Assn of Engng Socs—June, 1903. No. 57448 C.

Foundations. George B. Francis. Considers the need of obtaining all possible information, discussing borings, piles, grillage, riprap, footings, concrete, etc. General discussion. 2200 w. Jour Assn of Engng Socs—June, 1903. No. 57446 C.

Highways.

Planning a New York-Chicago Highway. Robert Bruce. Reviews the history of various road enterprises and outlines the route most in favor for the construction of a national highway. Maps. 3500 w. Automobile—Aug. 1, 1903. No. 57059.

New York Subway.

Section Nine of Division Three of the New York Rapid Transit Railroad. Illustrated detailed description of open trench construction is given in the present article. 3500 w. Eng Rec—Aug. 22, 1903. Serial. 1st Part. No. 57528.

Roofing.

Roofing Existing Shops While Work is Proceeding. R. H. Fowler. An illustrated description of a method of re-roofing shops without interfering with work. 1400 w. Inst Mech Engrs—July, 1903 No. 57123 D.

Tunnels.

A Brief Account of Recent Large Tunnel Works. Editorial on the extent of this work in Continental Europe. 1800 w. Eng News—Aug. 13, 1903. No. 57275.

London's "Tubes"—The Novel Method of Their Construction. Describes the novel features of the four tubes in process of construction. Ill. 2200 w. Sci Am Sup—Aug. 22, 1903. No. 57295.

The Construction of the Simplon Tunnel. The present article gives the history of the project, explaining the relation of the tunnel to existing routes, and describing engineering features of connecting lines. Ill. 3500 w. Eng News—Aug. 13, 1903. Serial. 1st part. No. 57271.

The Hudson River Tunnel. An interesting illustrated article giving history and description of work of construction of the tunnel which is to give communication between the trolley sytems of New York and Jersey City. 1700 w. Sci Am—Aug. 22, 1903. No. 57294.

The Simplon Tunnel (Der Simplondurchstich). H. Baum. A general description of the work with numerous illustrations showing the methods and progress down to the close of 1902. 7000 w. 2 plates. Glückauf—July 18, 1903. No. 57337 D.

MATERIALS.

Brick.

The Argilo-Calcareous or Sand-Lime Brick (Girard-Meurer Process). From *Stone Trades Journal.* Describes these bricks and the process of manufacture. They are composed of sand, lime and clay, hardened by means of steam under pressure. 2000 w. Am Archt—Aug. 1, 1903. Serial. 1st part. No. 57036.

Cement.

Manufacture of Cement from Marl and Clay. Discussion of paper by Henry S. Spackman. 2700 w. Pro Engrs' Club of Phila—July, 1903. No. 57454 D.

Portland Cement and Blast Furnace Slag (Portlandzement und Hochofenschlacke). Dr. H. Passow. An exhaustive study of the constitution of Portland cement, with micrographs of cements and clinker, showing the applicability of certain slags for making Portland cement. 6000 w. Stahl und Eisen—Aug. 1, 1903. No. 57334 D.

Portland Cement Manufacture. Edwin C. Eckel. In the present paper an account is given of the excavation and transportation to mill of the raw cement materials and the cost. 1400 w. Munic Engng—Aug., 1903. No. 57208 C.

Tests of Portland Cement Mortar Exposed to Cold. C. S. Gowen. Read before the Am. Soc. for Test. Materials. An account of experiments made to secure definite information on the effect of frost under the different conditions in which it may be desired to use Portland cement mortar in cold weather. Also Editorial. 2800 w. Eng News—July 30, 1903. No. 57040.

The Portland Cement Industry. Percy F. Balfour, in *Queens' Quarterly.* Reviews the history of the development of this industry in various countries. 3000 w. Can Archt—Aug., 1903. No. 57503 B.

Concrete.

A Concrete Measuring, Feeding, and Mixing Plant. Describes and illustrates the concrete apparatus of the Columbian Cordage Co., at Auburn, N. Y. 1500 w. Eng Rec—Aug. 15, 1903. No. 57260.

Effect of Water and Combinations of Sand on the Setting and Strength of Concrete. E. S. Larned. Abstract of a paper read before the Am. Soc. of Test. Materials. Reports a series of tests made by the writer, considering the results. 2200 w. Eng News—Aug. 6, 1903. No. 57160.

The Strength of Concrete as Affected by Different Percentages of Water. T. L. Doyle and E. R. Justice. Abstract of a thesis at the Univ. of Penna. Describes experimental investigations to determine the relation of strength between dry, medium wet, and wet mixtures. 800 w. Eng News—July 30, 1903. No. 57039.

Iron.

Iron. Prof. Aitchison. Some remarks on architecture and what it does for a country, and an interesting dissertation on the use of iron as a building material. Ill. 6800 w. Jour Ry Inst of Brit Archts —June 27 and July 25, 1903. Serial. 2 parts. No. 57470 each B.

Reinforced Concrete.

A Concrete-Steel Water Tower Near Boston. Illustrated description of a standpipe and tower of Hennebique armored concrete construction. 1000 w. Eng Rec —Aug. 22, 1903. No. 57530.

Comparative Tests of Beams of Reinforced Concrete (Essais Comparatifs de Poutres en Beton Armé). Data and results of tests of beams of the Maciachini type and ordinary reinforced concrete beams. 3000 w. Beton und Eisen—No. III., 1903. No. 57320 H.

Notes on Compound Structures (Einiges über Verbundkörper). Adolf Francke. A mathematical study of the combined resistance of the two materials in structures of concrete and iron. 5000 w. Beton und Eisen—No. III., 1903. No. 57318 H.

Rational Formulas for the Strength of a Concrete-Steel Beam. S. E. Slocum. Aims to develop a method of simple, rational analysis of a simple form of concrete-steel beam. 3000 w. Eng News—July 30, 1903. No. 57042.

Sixteen-Story Concrete-Steel Office Building at Cincinnati, O. An illustrated detailed description of the construction work of the Ingalls building. 5000 w. Eng News—July 30, 1903. No. 57037.

Tests upon Lattice Beams, Visintini System (Einige Versuche mit Gitterbalken, System Visintini). Illustrated account of tests of reinforced-concrete beams of the Visintini type by direct leading. 4000 w. Beton und Eisen—No. III., 1903. No. 57322 H.

Tests upon the Bond of Union between Concrete and Steel. C. W. Spofford. Tabulated report of tests made at the Mass. Inst. of Technology. The rods used were of the Ransome, Thacher, and Johnson types. 1800 w. Beton und Eisen—No. III., 1903. No. 57323 H.

The Calculations for Arches of Reinforced Concrete (Die Berechnung von Gewölben aus Eisenbeton). Dr. Max R. v. Thullie. A graphical and analytical study, showing the distribution of stresses for various combinations of iron and concrete in arch construction. 5000 w. Beton und Eisen—No. III., 1903. No. 57319 H.

The Computation of Double-Reinforced Concrete Beams (Ueber die Berechnung von Beiderseits Armierten Betonbalken). F. von Emperger. Data and results of tests of beams of concrete reinforced with iron rods near both upper and lower edges. 12000 w. Beton und Eisen—No. III., 1903. No. 57321 H.

The Construction of Flat Ceilings for Houses (Note sur les Planchers à Plafond Plat des Maisons d'Habitation). Illustrating and describing the systems of Hennebique, Boussiron, and Matrai. 2000 w. 1 plate. Beton und Eisen—No. III., 1903. No. 57316 H.

The Strasburg Music Hall (Das Sängerhaus in Strassburg). E. Züblin. Illustrated description of large auditorium and club house built in reinforced concrete. 3000 w. 3 plates. Beton und Eisen —No. III., 1903. No. 57315 H.

The Visintini System (Das System Visintini). A system of reinforced concrete beams of open lattice work of concrete with metal rods imbedded. 1800 w. Beton und Eisen—No. III., 1903. No. 57317 H.

Stone.

Quarries and Stone Working in Havana. Information based largely on the report prepared by Mrs. Harriet Connor Brown. 2500 w. Stone—July, 1903. No. 57210 C.

Testing.

The Underwriters' Laboratories. Day Allen Willey. Illustrates and describes a laboratory in Chicago for testing the utility of all fire resisting materials and systems, as well as apparatus used. 2000 w. Sci Am Sup—Aug. 22, 1903. No. 57400.

See Mechanical Engineering, Materials.

Wood Fireproofing.

Fireproofed Wood as a Building Material. Prof. Ira H. Woolson. Prepared for the International Fire Prevention Congress. Discusses the increasing use, especially in New York, of fire-resistant wood, the testing, quality, etc., the advantages and failings of the material. 4000 w. Archt, Lond—July 31, 1903. No. 57071 A.

Wood Preservation.

Preservation of Wood. Translated from *La Chronique Industrielle*. Briefly describes a number of methods in use. 2700 w. Sci Am Sup—Aug. 8, 1903. No. 57173.

MEASUREMENT.

Instrument.

The Richards Prismatic Stadia as a Range-Finder. E. K. Landis. Describes the use of this instrument as a range finder, giving results obtained. 1800 w. Pro Engrs' Club of Phila—July, 1903. No. 57455 D.

Slope Stakes.

A Graphical Method of Setting Slope Stakes. J. M. Rudiger. Describes a simple and effective method, giving diagram. 700 w. Eng News—July 30, 1903. No. 57043.

Tachymeter.

The Hammer-Fennel Instrument for Stadia Work. Horace Andrews. Illustrated description of the recent improvements in this instrument. 1400 w. Eng News—Aug. 13, 1903. No. 57273.

Wind Resistance.

Experiments upon the Resistance of the Air (Expériences sur la Resistance de l'Air). G. Eiffel. A review of the observations made upon the Eiffel tower in Paris, showing the variations of the coefficient for different surfaces. 1200 w. Comptes Rendus—July 6, 1903. No. 57341 D.

MUNICIPAL.

Baths.

The Karl Müller Public Baths (Les Bains Publics Karl Müller). An illustrated description of handsome new public bath buildings at Münich, Bavaria. 1500 w. 1 plate. Génie Civil—July 18, 1903. No. 57308 D.

Boulevard.

The Grand Boulevard and Concourse, New York City. Map, cross-section, and description of the concourse which will connect Central Park with the park system north of the Harlem River. 1800 w. Eng Rec—Aug. 8, 1903. No. 57191.

Fire Losses.

The Prevention of Loss by Fire in the United States of America. Edward Atkinson. Prepared for the International Fire Prevention Congress. Calls attention to the different conditions which govern architecture in the United States, as compared with European states; discusses the construction of towns and cities, and their needs, and general conclusions in regard to fire protection. 7000 w. Am Archt—Aug. 8, 1903. No. 57097.

Municipal Vehicles.

See Mechanical Engineering, Automobiles.

Pavements.

Bitulithic Pavement in Nashville. W. W. Southgate. Discusses the principles of its construction and its points of excellence. Ill. 1500 w. Munic Jour & Engr—Aug., 1903. No. 56899 C.

Brick Pavements at Syracuse, N. Y. An illustrated article reporting the amount of brick pavement laid, its cost, and condition after ten years' wear. 2000 w. Brick—Aug., 1903. No. 56871.

Refuse.

The Horsfall Refuse Destructor and Forced Draught System. Information of results obtained with this type of destructor. Ill. 1400 w. Elec Rev, Lond—July 31, 1903. No. 57117 A.

Sewage.

On the Distribution of Sewage on Bacteria Beds. John C. Thresh, and Martin Priest. Abstracted from a paper read before the Inst. of San. Engrs. A discussion of the best means for the distribution. 1500 w. Engr, Lond—July 24, 1903. No. 57032 A.

Sewage Pollution of Water Supplies. Editorial review of recent court decisions. 1600 w. Eng Rec—Aug. 1, 1903. No. 57094.

The Royal Commission on Sewage-Disposal. Reviews the third report of the Commissioners, the evidence already accumulated and conclusions as to methods which may be properly adopted. 3500 w. Builder—July 25, 1903. No. 57010 A.

Sewers.

The High-Level Sewer of the Metropolitan Sewerage District of Massachusetts. John S. Hodgson. Map showing the various systems of sewers and profile of the outfall pipe of the high-level sewer, with descriptive notes. 1800 w. Ill. Eng Rec—Aug. 15, 1903. No. 57259.

Street Cleaning.

Street Cleaning in San Francisco. L. M. King. Gives a resumé of the methods employed under the present system, with the results. 1200 w. Eng News—Aug. 20, 1903. No. 57542.

Trenches.

The Back Filling of Trenches. W. F. Raymond. Gives the writer's views of the best method. 1400 w. Munic Engng—Aug., 1903. No. 57209 C.

WATER SUPPLY.

Anchor Ice.

Experience with Anchor Ice at the Detroit Water-Works and Elsewhere. C. W. Hubbell. From the Michigan *Technic* for 1903, Univ. of Mich. Describes anchor ice difficulties and attempted remedies. 4300 w. Eng News—Aug. 13, 1903. No. 57276.

Atlantic City.

The Water-Works of Atlantic City, N. J. Illustrates and describes a system designed to meet unusual conditions, and give fire protection to about 700 hotels, mostly constructed of wood. 2500 w. Eng Rec—Aug. 22, 1903. No. 57529.

Australia.

Water for the Gold Fields of Western

Australia. D. M. Bates. An illustrated account of the great engineering feat to furnish water for the Coolgardie and Kalgoorlie gold fields. 3500 w. Cassier's Mag—Aug., 1903. No. 57279 B.

Filtration.

Ferrous Sulphate as a Coagulant in the Mechanical Filtration of Water. Ernest E. Irons. Describes the plant at Quincy, Mass., where solutions of ferrous sulphate and lime water in the proper proportions, are added to the water, with resulting coagulation followed by rapid subsidence. 2500 w. Eng Rec—Aug. 8, 1903. No 57193.

Protection of Gathering-Grounds and Filtration Compared. Prof. S. Delépine. Summary of a paper read at the meeting of the British Assn. of Water-Works Engrs., with editorial. A comparison as to which system possessed the greater merits, favoring protection of sources of supply. Editorial disapproval and discussion. 5000 w. Jour Gas Lgt—Aug. 11, 1903. No. 57292 A.

Fire Protection.

Fire Protection Water Works. Nicholas P. Simin. Describes American and Russian practice. Ill. 2500 w. Munic Jour & Engr—Aug., 1903. No. 56898 C.

Irrigation.

Drainage of Irrigated Lands. Ernest McCullough. Shows how drainage practice in the West varies from accepted practice in the East, and why. 3300 w. Eng News—Aug. 20, 1903. No. 57540.

Masonry and Steel Head-Gate of the Grand Valley Irrigation Canal, Colorado. Clarence T. Johnson. Illustrations, with brief description. 700 w. Eng News—Aug. 13, 1903. No. 57274.

Jerome Park, N. Y.

Report of the Commission of the Jerome Park Reservoir. Report on the condition of the walls, discussing the water-tightness of the retaining walls and the best methods of securing a water-tight bottom of concrete, and the use of stone dust in the place of sand and mortar. 5400 w. Eng News—Aug. 6, 1903. No. 57161.

Jersey City.

The New Water-Works of Jersey City. An illustrated article giving information of work on the Boonton dam of the Jersey City water-works, and detailed description. Also describes the building of the core wall at the Parsippany dyke. 4800 w. Eng Rec—Aug. 8, 1903. No. 57189.

Microscopy.

The Value of Microscopical Study in the Selection of Water (Die Bedeutung der Mikroskopischen Untersuchungsmethode für die Beurteilung des Wassers). Dr. G. Lindau. Emphasizing the importance of a continual study of a drinking water supply by microscopical examination. 2500 w. Gesundheits-Ingenieur—July 20, 1903. No. 57332 B.

Philadelphia.

Improvement, Extension, and Filtration of the Water Supply of Philadelphia. John W. Hill. An illustrated article describing work in progress and calling attention to features of interest. General discussion. 17300 w. Pro Engrs' Club of Phila—July, 1903. No. 57453 D.

Pipe Cleaning.

A New Pipe-Scraping Machine. C. C. Smith. Abstract of a paper read before the British Assn. of Water-Works Engrs. Illustrated description of a machine which will successfully cleanse pipes under 4-in. in diameter. The invention of a German, Mr. Nowotny. 1000 w. Ir & Coal Trds Rev—July 24, 1903. No. 57033 A.

Town Supply.

Water Supply Engineering for Towns. P. Byrne. Read before the Engng. Assn. of the South. Discusses briefly points to be considered when water-works become a necessity. 2200 w. Munic Jour & Engr —Aug., 1903. No. 56897 C.

Water Tower.

See Civil Engineering, Materials, Reinforced Concrete.

ELECTRICAL ENGINEERING

COMMUNICATION.

Cuba.

The New Cuban Telegraph Service. Charles Minor Blackford. Maps showing old and new lines, with explanatory notes. 700 w. Sci Am Sup—Aug. 22, 1903. No. 57298.

Pacific Cable.

The Pacific Cable. Reviews the various attempts to give cable communication across the Pacific, and the final success, discussing the importance of the event. 2000 w. Gunton's Mag—Aug., 1903. No. 56864.

Space Telegraphy.

Hertzian Wave Telegraphy. Dr. J. A. Fleming. Cantor lectures. The first lecture of a series on the variety of telegraphy without continuous wires, in which Hertzian electric waves are employed; deals with the appliances used and the theory of their operation. 11500 w. Jour Soc of Arts—July 24, 1903. Serial. 1st part. No. 57207 A.

Phenomena of the Antennæ in Wireless Telegraphy (Sur les Phénoménes de l'Antenne de la Télégraphie sans Fils). MM. Broca and Turchini. A description of investigations made, with a form of electro-dynamometer especially devised for the study of the action of the currents in the antennæ. 1200 w. Comptes Rendus—June 29, 1903. No. 57340 D.

The Fessenden System of Spark Telegraphy (Die Funkentelegraphie nach Fessenden). H. Lindow. An abstract of the Fessenden wireless telegraphy patents. 6000 w. Elektrotech Zeitschr—July 23, 1903. No. 57347 B.

The Lodge-Muirhead System of Wireless Telegraphy. A. Frederick Collins. An account of the development of this system, with illustrated description of its novel features. 3000 w. Elec Wld & Engr —Aug. 1, 1903. No. 57090.

Telephony.

Is State Ownership of Telephones Desirable? F. Dagger. Information regarding the results of government ownership in Austria, Belgium, France, Germany, Switzerland, and Luxemburg, showing the service generally unsatisfactory. 1600 w. Can Engr—Aug., 1903. No. 57134.

Properties of Wire Used in Telephone Work. R. A. L. Snyder. Considers the seven kinds of wire used, and their different properties, and the uses of each. 1000 w. Pro Engrs' Soc of W Penn—June, 1903. No. 57464 D.

The New Denver Telephone Exchange of the Colorado Telephone Company. C. W. Whitney. An illustrated detailed description of the building and its equipment. 4800 w. Elec Wld & Engr—Aug. 22, 1903. No. 57536.

DISTRIBUTION.

Cables.

The Heating of Buried Cables (Ueber die Erwärmung im Erdboden Verlegter Starkstromkabel). Paul Humann. Data and results of experiments made by Felten and Guillaume upon the heating of buried cables subjected to the passage of heavy currents. 3000 w. Elektrotech Zeitschr—July 30, 1903. No. 57348 B.

Conductors.

Methods of Bringing High Tension Conductors into Buildings. C. E. Skinner. Discusses the general requirements, referring to specific methods. Ill. 1200 w. Trans Am Inst of Elec Engrs—July, 1903. No. 57418 D.

Conduits.

Electric Conduit Construction at Cincinnati, O. Illustrated description of a very extensive underground conduit system for the purpose of supplying current to the street arc lamps. 2500 w. Eng News—Aug. 20, 1903. No. 57541.

Converters.

American Converters (Ueber Amerikanische Umformer). A. Hruschka. A review of American practice in the use of converters and transformers in electric tramway service. 3500 w. Elektrotech Zeitschr—July 23, 1903. No. 57344 B.

Energy Transformations in the Synchronous Converter. William S. Franklin. The object of the paper is to determine the fractional part of the total energy which is conductively transferred from supply mains to service mains and the part which is inductively transferred. 3500 w. Trans Am Inst Elec Engrs—July, 1903. No. 57404 D.

Storage Batteries.

The Storage Battery in Sub-stations. W. E. Goldsborough and P. E. Fansler. An account of tests made on a large interurban system to determine the storage battery equipment needed and showing the character of the demands which the battery has to meet. Ill. 7800 w. Trans Am Inst of Elec Engrs—July, 1903. No 57410 D.

Sub-Stations.

The Sub-Stations of the Elevated Railways in New York (Die Unter-Stationen der New Yorker Hochbahn). S. S. G. Freund. Illustrated description of the transforming sub-stations in New York, in which the current from the main station at 77th street is reduced and converted for delivery to the third rail. 2500 w. Elektrotech Zeitschr—Aug. 6, 1903. No. 57351 B.

Switches.

Automatic Release for High-Tension Switches (Ueber die Auslösung von Automatischen Hochspannungsschaltern). Max Vogelsang. Illustrating a special form of automatic switch for action by continuous current. 1800 w. Elektrotech Zeitschr—July 30, 1903. No. 57-349 B.

High Pressure Oil Switches (Hochspannungs-Oelschalter). Dr. G. Benischke. A discussion of the advantages of oil insulation for switches for high-pressure currents, with examples of construction. 2500 w. Elektrotech Zeitschr—July 30, 1903. No. 57350 B.

Transformers.

Effect of Series Resistance in the Primary Circuit of a Transformer. H. A Pikler. Shows that by sending a sine wave exciting current through the transformer we get the e. m. f. wave distorted. 1200 w. Elec Wld & Engr—Aug. 8, 1903. No. 57157.

High Tension Transformers. J. W. Farley. Describes the transformers as typical of the latest and best engineering practice in the design of high tension apparatus. 3700 w. Cent Sta—Aug., 1903. No. 57166.

Leblanc Rectifying Transformer. Explains the fundamental principle of this invention. 2000 w. Elec Wld & Engr—Aug. 22, 1903. No. 57539.

Y or Δ Connection of Transformers. F. O. Blackwell. Also discussion by J. S. Peck. A general statement of the advantages and disadvantages of both connections, as they appear to the writer. Mr. Peck discusses the question of grounding or not grounding the neutral and the best method of connecting transformers. 4300 w. Trans Am Inst of Elec Engrs—July, 1903. No. 57419 D.

Wiring.

Alternating Current Wiring. Cecil P. Poole. Tables, formulæ and directions for making the necessary calculations 2000 w. Am Elect'n—Aug., 1903. No. 57088.

Electric Wiring and Fire Risks. E. C. de Segundo. Read before the International Fire Prevention Cong. On the importance of sound work in the wiring of buildings for electric light and power. 3000 w. Archt, Lond—Aug. 14, 1903. No. 57471 A.

ELECTRO-CHEMISTRY.

Accumulator.

The Jungner-Edison Accumulator (Der Jungner-Edisonsche Akkumulator). M. U. Schoop. A comparison of the lead and the alkali accumulators, with data of tests, and a summing up of the advantages and defects of the respective types. 4500 w. Elektrotech Zeitschr—Aug. 6, 1903. No. 57352 B.

Alkali Earths.

The Electrolysis of Sulphides of the Alkali Earths (Ueber die Elektrolyse der Erdalkalisulfide). André Brochet and Georges Ranson. An account of experimental researches, principally with barium sulphide. 1500 w. Zeitschr f Elektrochemie—June 25, 1903. No. 56957 G.

Cerium.

The Electromotive Force of Cerium Oxide (Ueber das Elektromotorische Verhalten der Oxyde des Cers). E. Baur and A. Glaessner. An experimental investigation of the oxidation and reduction electric potentials of solutions of cerium salts. 2000 w. Zeitschr f Elektrochemie—June 25, 1903. No. 56958 G.

Discoveries.

Electrochemical Discoveries. Reviews the industries that have grown up around Niagara, and the experimental companies formed for the purpose of discovering new processes. 1500 w. Sci Am—Aug. 1, 1903. No. 57049.

Electrodeposition.

Electrodeposition on Rotating Cathodes. J. G. Zimmerman. Gives data and observations obtained from an investigation of such means recently carried on at the Univ. of Wisconsin. 2000 w. Wis Engr—June, 1903. No. 57442 D.

Electro-Metallurgy.

The Development of Electro-Metallurgy (Ueber die Fortschritte der Elektrometallurgie). Dr. Heinrich Paweck. Paper before the Oesterr. Ing.- und Architektenverein, giving a general review, with bibliography. 2 Parts. 4000 w. Oesterr Zeitsch f Berg u Hüttenwesen—June 13 and 20, 1903. No. 56948 each D.

Ferrosilicon.

Ferrosilicon in France. Information concerning ferrosilicon manufactured by the electrical process, and a statement of the advantages of high-grade ferrosilicon. 1800 w. U S Cons Repts, No. 1713—Aug. 3, 1903. No. 56876 D.

Lead Salts.

The Anode Potential During the Formation of Lead Carbonate and Lead Chromate (Ueber Anodenpotentiale bei Bildung von Bleikarbonat und Bleichromat). G. Just. Electrolytic experiments with lead electrodes. Tables. 1000 w. Zeitschr f Elektrochemie—July 2, 1903. No. 56959 G.

Separation.

Notes on the Quantitative Electrolytic Separation of Metals (Beiträge zur Kenntnis der Quantitativen Elektrolytischen Metallabscheidung). P. Denso. A description of laboratory methods of ananalysis, with illustration, diagrams and tables. 3500 w. Zeitschr f Elektrochemie—June 4, 1903. No. 56951 G.

Steel Making.

Manufacture of Steel by the Electric Furnace. Translation published in *Iron Age,* with additions by P. McN. Bennie of a paper by Charles Bertolus, of St. Etienne, France, entitled "Notice sur la Fabrication des Aciers au Four Electrique." 4800 w. Sci Am Sup—Aug. 1, 1903. No. 57054.

Thallium Accumulator.

The Thallium Accumulator (Ueber den Thallium-Akkumulator). L. Jonas. Theoretical and experimental investigations. 3000 w. Zeitschr f Elektrochemie—June 25, 1903. No. 56956 G.

ELECTRO-PHYSICS.

Electrostatics.

To Whom Do We Owe the Experiment of the Ball and Hemispherical Conductors, Showing That the Charge Resides on the Outer Surface of an Electrified Body? Brother Potamion. Shows that the experiment was first performed by Cavindish, in 1773, and that the benefit to the world came through the work of Coulomb, 1788. 1700 w. Elec Wld & Engr—Aug. 22, 1903. No. 57537.

Magnetic Observatories.

The Magnetic Observatories of the United States Coast and Geodetic Survey in Operation on July 1, 1902. L. A. Bauer and J. A. Fleming. From the annual report of the Supt. of the U. S. Coast & Geodetic Survey, 1902. Illustrated descriptions. 3300 w. Sci Am Sup—Aug. 8, 1903. No. 57174.

Precision.

The Necessity for Precision of Statement in Technical Work. H. M. Hobart. Especially considers the subject in its bearing on electrical work, illustrating by important questions which have been only superficially discussed. 1600 w. Elec Rev, Lond—Aug. 7, 1903. Serial. 1st part No. 57227 A.

Radioactivity.

Experiments in Radioactivity, and the Production of Helium from Radium. Sir William Ramsay and Mr. Frederic Soddy. Report of experimental investigations. 1500 w. Nature—Aug. 13, 1903. No. 57468 A.

On the Intensely Penetrating Rays of Radium. Hon. R. J. Strutt. A report of results of investigations made. 600 w. Nature—Aug. 13, 1903. No. 57469 A.

Radioactivity of Thorium Minerals. George F. Barker. A review of recent investigations and the conclusions reached. 2800 w. Am Jour of Sci—Aug., 1903. No. 57434 D.

To Manufacture Radium. An account of a company formed to extract the rare metal radium from uranium ores obtained from Utah beds. 800 w. Ir Age—Aug. 27, 1903. No. 57561.

Resonance.

On Resonance Coils. T. Mizuno. Shows the advantages of the coil system in investigating electric waves, and describes methods of investigation. Ill. 1500 w. Elect'n, Lond—Aug. 7, 1903. Serial. 1st part. No. 57228 A.

Static Discharge.

Eccentricities of the Static Discharge. Walton Harrison. Illustrates and describes an experiment of Hertz, and modifications by other investigators. 700 w. Sci Am—Aug. 8, 1903 No. 57167.

GENERATING STATIONS.

Alternating Current.

The Management of Alternating Current Machinery. George T. Hanchett. Suggestions for successful operation. Ill. 2000 w. Cent Sta—Aug., 1903. No. 57165.

Alternators.

Commercial Alternator Design. W. L. Waters. An illustrated discussion of various designs and of the chief factors in deciding the design of a machine. 4300 w. Trans Am Inst of Elec Engrs—July, 1903. No. 57405 D.

Apprentices.

Notes on What and How to Learn in an Electrical Engineering Works. G. Ralph. Calls attention to things an apprentice should look out for in the various departments. 2200 w. Elec Engr, Lond—Aug. 7, 1903. No. 57224 A.

Belfort.

Electric Works at Belfort. Illustrated detailed description of these model shops. 1000 w. Engr, Lond—July 31, 1903. No. 57129 A.

Brussels.

Electrical Installation of the City of Brussels, Belgium. Enrico Bignami. An illustrated article describing the character of the work necessary to keep up with the growth of the city and demand for increased service. 2800 w. Elec Rev, N. Y.—Aug. 15, 1903. No. 57258.

Coil Forming.

See Mechanical Engineering, Machine Works.

Combined Plant.

A Combined Railway, Lighting and Ice Plant at Hampton, Va. An illustrated detailed description of a noteworthy example of a combined plant. 4000 w. St Ry Jour—Aug. 15, 1903. No. 57253 D.

Costs.

Economy of Fuel in Electric Generating Stations. Henry McLaren. Remarks based on table of costs published by *The Electrical Times*, London, with suggestions for better economy. 4500 w. Inst Mech Engr—July, 1903. No. 57121 D.

Demand.

Some Observations on Electricity Supply and Methods of Stimulating Demand. J. E. Panton. Brief review of the development of electric supply undertakings in England, with discussion of important features. Considers reliability of service and cost as of first importance, and suggests means of increasing the supply. 4800 w. Elec Engr, Lond—July 31, 1903. No. 57116 A.

Diesel Motor.

See Mechanical Engng., Special Motors.

Disconnecting.

The Use of Automatic Means for Disconnecting Disabled Apparatus. H. G. Stott. Discusses generating apparatus, transmission apparatus, and receiving apparatus, giving suggestions for safety. 1200 w. Trans Am Inst of Elec Engrs—July, 1903. No. 57424 D.

Dresden.

The Electrical and Heating Station in Dresden (Das Fernheiz und Elektrizitätswerk in Dresden). General description of steam power plant and electric generating sation, including long-distance distribution of steam for heating purposes. 2,000 w. Schweizerische Bauzeitung—July 18, 1903. No. 57329 B.

Economies.

Central Station Economies. W. E Goldsborough and P. E. Fansler. An account of a comprehensive test made to determine the economies of the main power station of the Union Traction Co., of Indiana. Ill. 7800 w. Trans Am Inst of Elec Engrs—July, 1903. No. 57408 D.

Failures.

Electrical Plant Failures, Their Origin and Prevention. A. Campbell Cormack. Statistics of accidents showing their nature, the origin, and giving an analysis of the causes. 3000 w. Elect'n, Lond—Aug 14, 1903. No. 57487 A.

Generators.

Care and Management of Electric Generators. Edwin W. Creed. Suggestions from practical experience, useful to men having the care of this kind of machinery. Ill. 2500 w. Power—Aug., 1903. No. 56866 C.

"Hunting."

The "Hunting" of Alternating-Current Machines. Bertram Hopkinson. Communication to the Royal Society. An investigation of causes and a study of the general effect upon stability of running. 6000 w. Elect'n, Lond—Aug. 7 and 14, 1903. Serial. 2 parts. No. 57229 each A.

Hydro-Electric Plants.

A Mexican Water-Power Electric Plant. Illustrated description of a small but interesting plant at San Simonito, supplying current for lighting and power to Toluca, and other towns and villages within twenty miles. 2000 w. Eng News—Aug. 13, 1903. No. 57277.

Electric Power from Mount Rainier. Brief illustrated description of a plant utilizing the glaciers of Mount Rainier as a source of water supply. 1000 w. Rev of Revs—Aug., 1903. No. 57206 C.

Hydraulic-Electric Development of the Neversink Light and Power Company, Middletown, N. Y. Illustrated description of an interesting development which utilizes the abandoned works and canal of the Delaware & Hudson Canal Co. 1700 w. Elec Wld & Engr—Aug. 8, 1903. No. 57156.

Hydro-Electric Power Stations in Italy. This article describes and illustrates the power station of Vizzola, on the river Ticino. Brief reference is made to other interesting stations. 1800 w. Elec Rev, Lond—July 24, 1903. No. 57019 A.

Power-Development in Southern California. L. R. Freeman. Remarks on the value of water in California, especially in the arid regions, with an account of the great power development and transmission plants, with brief description of the Edison Co. Mill Creek Plant, No. 3. Ill. 1700 w. Rev of Revs—Aug., 1903. No. 57205 C.

The Cauvery Falls Hydro-Electric Plant (Usine Hydro-Electrique de Cauvery Falls). F. Drouin. An illustrated description of the plant at Sivasamudram, in southern India; 7,500 h. p. are taken from the falls of the Cauvery river. 2500 w. 1 plate. Génie Civil—July 25, 1903. No. 57310 D.

The Electric Generating Station at Gersthofen on Lech (Das Elektrizitätswerk Gersthofen am Lech). Kurt Meyer. An illustrated description of the plant at Gersthofen near Augsburg, Bavaria, where 6,000 H. P. is taken from the Lech, and delivered to Augsburg and the vicinity for lighting and electro chemical industries. Serial. Part 1. 3000 w. Zeitscher d Ver Deutscher Ing—July 18, 1903. No. 57,301 D.

The great Electric Installations of Italy. E. Bignami. A fully illustrated description of the power plant at Tivoli and the transmission of electrical energy to Rome. 3000 w. Enginering Magazine—Sept., 1093. No. 57362 B.

The Harnessed Hudson. Thomas Commerford Martin. Reviews the rapid development of water power in the United States, especially considering the recent work at Spiers Falls. Ill. 1400 w. Rev of Revs—Aug., 1903. No. 57204 C.

Insulation.

Defective Machine Insulation. C. E. Farrington. On the defective insulation which is found in modern dynamo and motor construction, outlining investigations made to determine a good insulating compound. 3800 w. Jour Fr Inst—Aug., 1903. No. 57438 D.

Niagara.

Canadian Electrical Development at Niagara. A brief account of the extensive work being carried out, with map. 600 w. Engr, Lond—Aug. 7, 1903. No. 57238 A.

Power Companies.

The Sphere of Utility of a Power Company. Alderman G. Pearson. Read before the Munich Elec. Assn. at Newcastle-on-Tyne. Discusses the question as related to England particularly, with aim of finding some common ground of agreement between power companies and municipalities, whereby they may be able to avoid competition. 3300 w. Elec Engr, London—July 24, 1903. No. 57017 A.

Power Plants.

See Mechanical Engineering, Steam Engineering.

Storage Batteries.

The Storage Battery in Its Relation to U. S. Fortifications. Lee Hagood. Facts about the storage battery, with special reference to its applications and use in seacoast fortifications. Considers the technical features, care and management of these batteries. 7000 w. Ill. Jour U. S. Art—July-Aug., 1903. Serial. 1st part. No. 57549 D.

Tramway Stations.

A 57,000 Kilowatt Steam Turbine Station. Brief illustrated description of the principal features of the generating station under construction at Chelsea, Eng., by the Underground Elec. Ry. Co., of London, Ltd. 1000 w. Power—Aug., 1903. No. 56867 C.

New High Tension Alternating Current Installation of the Berkshire Street Railway Company at Pittsfield, Mass. W. G. Viall. Illustrated detailed description. 3000 w. Am Elect'n—Aug., 1903. No. 57084.

The Missouri River Power Station of the Metropolitan Street Railway Company of Kansas City, Mo. Illustrated detailed description of one of the largest power stations in the United States. Curtis steam turbines are to be installed. 4000 w. St Ry Jour—Aug. 1, 1903. No. 57081 D.

Wimbledon.

Wimbledon Electricity Works. Illustrated description of a combined refuse destructor and electricity works for a residential suburb of London. The town has a very remarkable development of street lighting by electricity which is entirely controlled from the generating station. 2800 w. Elec Rev, Lond—Aug. 14, 1903. No. 57482 A.

LIGHTING.

Car Lighting.

An Electric Car Lighting System. W. L. Bliss. An illustrated description of an axle-driven electric car lighting system in which the generator is located on the truck frame, the armature being rotated by means of a single reduction gearing. 6800 w. Pro St Louis Ry Club—July 10, 1903. No. 57429.

Train Lighting with Steam Turbines. Geheimrath Weichert. Abstract translation from a report on the Prussian Nat. Rys. presented at the German Engrs. convention. Illustrated detailed description of the system adopted, with brief review of other systems. 4000 w. Sci Am Sup—Aug. 1, 1903. No. 57053.

Economies.

The Possibilities of Future Economies in Electrical Illumination. W. A. Chamen. Read before the Incor. Munic. Elec. Assn. Discusses incandescent lamps, the Howitt mercury vapor lamp, arc lamps, and the possible improvements. Short discussion. 4500 w. Elect'n, Lond—July 24, 1903. No. 57020 A.

Hot Wire.

Hot Wire Enclosed Arc Lamps. H. Tomlinson-Lee. An illustrated article describing the "hot-wire" lamp invented by C. E. Foster, with reports of its advantages. 1200 w. Elec Rev, Lond—July 31, 1903. No. 57118 A.

Lighthouse.

Modern Searchlights. Frank C. Perkins. Illustrates and describes the new form of electric flashlight installed in the lighthouse tower at Heligoland. 600 w. Sci Am—Aug. 22, 1903. No. 57293.

Torpedo Boats.

Electric Light Plant for Dutch Torpedo Boats. Illustrations and brief description of plant for working the search lights, and for general lighting purposes. 350 w. Engng—July 31, 1903. No. 57127 A.

MEASUREMENT.

Alternating Currents.

Power Measurement on Alternating-Current Circuits. R. B. Williamson. Considers points affecting the determination of power and methods of making power measurements. 2000 w. Elec Rev N. Y.—Aug. 15, 1903. Serial. 1st part. No. 57257.

Cable Testing.

Tests on Broken Cables—Some Inconsistencies in Localization Formulae. E. Raymond-Barker. Calls attention to various inconsistencies in text-book formulae, and summarizes the several formulae which have appeared. 1100 w. Elec Rev, Lond—Aug. 14, 1903. Serial. 1st part. No. 57480 A.

Meters.

The Influence of the Curve Form upon Induction Meters (Uber den Einfluss der Kurvenform auf Induktionszähler). Dr. G. Stern. An examination of alternating meters of the Ferraris type, showing that the form of the alternating-current curve affects the readings. 3000 w. Elektrotech Zeitschr—July 23, 1903. No. 57345 B.

Motor Diagrams.

The Polar Diagram of the Compensated Motor (Das Kreisdiagramm des Kompensierten Motors). A. Heyland. An examination of the effect of compensation upon the induction motor, using the vector diagram, showing the degree of compensation and position of brushes giving maximum efficiency. 2500 w. Elektrotech Zeitschr—July 23, 1903. No. 57346 B.

Selector.

The Detection of the Finishing Temperature of Steel Rails by the Thermo-Magnetic Selector. Albert Sauveur and Jasper Whiting. Describes a method of testing to prevent the rolling of coarsely crystalline rails, illustrating the most promising devices yet conceived for meeting the requirements. 1400 w. R R Gaz—Aug. 14, 1903. No. 57270.

Self Induction.

A Method of Determining the Coefficient of Self Induction (Methode zur Vergleichung von Selbstinduktionskoefficienten und Kondensatoren). Dr. G. Brion. Describing the method using the wheatstone bridge, with a telephone instead of a galvanometer. 1200 w. Elektrotech Zeitschr—Aug. 6, 1903. No. 57353 B

Testing.

The Testing of Electrical Apparatus for Dielectric Strength. P. H. Thomas. A brief dissension of objections to the present method of over potential tests, especially in regard to insulation tests upon very high tension apparatus. 3000 w. Trans Am Inst of Elec Engrs—July, 1903. No. 57417 D.

Wattmeters.

Some Tests of Recording Wattmeters. Ingwald A. Rosok. An account of tests made of several makes. 1200 w. Elec Wld & Engr—Aug. 22, 1903. No. 57538.

POWER APPLICATIONS.

Agriculture.

The Use of Electric Power in Plowing. Emile Guarini. Illustrated description of some new applications of electricity to the cultivating of farms. 2400 w. Elec Rev, N. Y.—Aug. 8, 1903. No. 57148.

Battleship Installation.

The Electric Installation on Board U. S. Battleships Connecticut and Louisiana. R. M. Klein. Illustrated detailed description of the electric applications aboard these ships and the plants for handling the entire load. 7000 w. Elec Wld & Engr—Aug. 15, 1903. No. 57265.

Coal Hoist.

An Electrically-Operated Coal Hoist. Richard Lamb. Illustrates and describes a plant that does not use varying voltage generators. 1500 w. Elec Wld & Engr—Aug. 1, 1903. No. 57093.

Cranes.

Electric Harbor Cranes (Ueber Elektrische Hafenkräne). J. Rothmüller. Illustrating and describing various forms of cranes for use on docks, quays and other harbor service, showing the extent to which electricity has replaced hydraulic power. 3000 w. Zeitschr d Oesterr Ing u Arch Ver—July 17, 1903. No. 57327 D.

Dredge.

Electrically-Driven Ladder Dredge. Illustrated description of a ladder dredge in use on the river Esla, in Spain, which is electrically driven throughout. 800 w. Marine Engng—Aug., 1903. No. 56895 C.

The Electrical Equipment of a Gold Dredge. Ralph L. Montague. Explains the use and object of these dredges and describes the electrical equipment. Ill. 3800 w. Trans Am Inst of Elec Engrs—July, 1903. No. 57407 D.

Electric Locomotives.

See Street and Electric Railways.

Electric Traction.

See Street and Electric Railways.

Induction Motor.

Design for a One Horse-Power Self Starting Single-Phase Induction Motor. Drawings and description of the essential features of a motor capable of giving one brake horse-power on a single-phase circuit of 100 volts and 125 to 133 cycles. 1800 w. Am Elect'n—Aug., 1903. No. 57087.

Mine Hoists.

The Electrical Driving of Winding Gears. F. Hird. Abstract of paper read before the Inst. of Min. Engrs. Describes the controlling apparatus used by different designers, and other features of interest. 3800 w. Elect'n, Lond—Aug. 14, 1903. No. 57485 A.

Mining.

Electrical Day at the Institution of Mining Engineers, London. Sidney F. Walker. A review of the electrical papers presented, and the discussions. 2000 w. Elec Rev, N. Y.—Aug. 1, 1903. No. 56896.

Electric Power Appliances in the Mines of Europe. Emile Guarini. M. Guarini's second paper deals with the direct applications of electric power to ore getting, hauling, and hoisting. 3500 w. Engineering Magazine—Sept., 1903. No. 57365 B.

Motor Diagrams.

See Electrical Engineering, Measurement.

Paper Mill.

The Electrical Plant of the Albbruck Paper Works in the Southern Black Forest (Elektrizitätswerk der Papierfabrik

Albbruck im Südlichen Schwarzwald). F. Allemann Gisi. A will illustrated detailed description of a hydro-electric plant in Baden, near the Rhine. 4 parts. 7000 w. Schweiz Bauzeitung—July 4, 11, Aug. 1 and 8, 1903. No. 56953 each D.

Speed Control.

Notes on the Speed Regulations of Continuous-Current Motors. Wallace Rogers. Considers the effect of weakening the field as a means of speed regulation, and its disadvantages. Also considers other methods both as regards stationary and traction work. 2200 w. Elec Engr, Lond —Aug. 14, 1903. No. 57478 A.

Woodworking.

Woodworking Machinery. Gives illustrated descriptions of various machines showing important developments in individual driving by electric motors. 1200 w. Am Engr & R R Jour—Aug., 1903. No. 56873 C.

TRANSMISSION.

Aluminum.

Aluminum Conductors of Electric Transmission Lines. Alton D. Adams. A comparison of the questions of the conductivity, cost and maintenance of aluminum lines and those of copper. 3000 w. Engineering Magazine—Sept., 1903. No. 57366 B.

Converters.

See Electrical Engineering, Distribution.

France.

The Recently Installed Saut-Mortier Electrical Power Transmission Plant in France. Frank C. Perkins. Illustrated description. 1500 w. Elec Rev, N. Y.—Aug. 22, 1903. No. 57526.

Frequencies.

Choice of Frequency for Very Long Lines. P. M. Lincoln. Discusses which is the better frequency for a very long line, 60 or 25 cycles per second, considered purely as a transmission problem. 1200 w. Trans Am Inst of Elec Engrs—July, 1903. No. 57420 D.

High Voltage.

Electric Cables for High Voltage Service. Henry W. Fischer. Discusses the manufacture of paper-insulated and rubber-insulated cables, their installation, and operation. 1200 w. Trans Am Inst of Elec Engrs—July, 1903. No. 57423 D.

High Tension Cables and Overhead Transmission. Charles C. Gerrard. A brief comparison of overhead and underground transmission with special reference to English conditions. 1500 w. Elec Rev, Lond—Aug. 14, 1903. No. 57479 A.

The Operation and Maintenance of High Tension Underground Systems. Philip Torchio. Notes applying mainly to moderately high-tension systems as installed in large cities in the last few years. Ill. 900 w. Trans Am Inst of Elec Engrs—July, 1903. No. 57422 D.

Lightning.

The Grounded Wire as a Protection Against Lightning. Ralph D. Mershon. Discusses the efficacy of wires strung parallel to the power wires and grounded at intervals for the protection of transmission lines. 1800 w. Trans Am Inst of Elec Engrs—July, 1903. No. 57421 D.

Switching.

Switching Transmission Circuits. Alton D. Adams. Outlines facts that have led to the development of oil switches, describing these switches and their operation. 4000 w. Elec Rev, N. Y.—Aug. 22, 1903. No. 57525.

Transformers.

See Electrical Engineering, Distribution.

MISCELLANY.

Shocks.

The Danger of Shock to Firemen Through Squirting High-Tension Mains. Abstract of an article by F. Heinicke in the *Elektrotechnische Zeitschrift*. An account of experiments carried out, with the conclusion that the danger from this source is not so great as supposed. 800 w. Elec Engr, Lond—Aug. 7, 1903. No. 57225 A.

GAS WORKS ENGINEERING

Acetylene.

Development in Acetylene. J. H. Chewett. Read before the Engrs. Club of Toronto. Reviews the history of the development and discusses the advantages and value of the gas. 2800 w. Can Engr —Aug., 1903. No. 57133.

Impurities and Purification of Acetylene. G. Kappeler, in the *Jour. of Gasbeleucht*. A resume of the impurities which have been discovered in acetylene, and the methods devised to improve them. 2000 w. Sci Am Sup—Aug. 8, 1903. No. 57-175.

The Principal Properties of Acetylene Solutions (L' Acetylene Dissons et ses Principales Applications). A. Janet. A description of the success which has been attended in the practical use of acetylene dissolved in acetone, especially for illuminating purposes and for the oxy-acetylene blowpipe. 2000 w. Génie Civil—July 18, 1903. No. 57309 D.

Benzine.

Determination of Benzine in Gas. L. M. Dennis and J. G. O'Neill. From the *Jour. Am. Chem. Soc.* An account of experimental investigations showing that alcohol does not completely remove either benzine or athylene, and that an ammoniacal solution of nickel nitrate furnishes a rapid and exact method for the determination. 3000 w. Jour Gas Lgt—Aug. 11, 1903. No. 57291 A.

Carbonizing.

The Settle-Padfield Carbonizing Process. Norton H. Humphreys. Notes and results of tests of interest. 900 w. Jour Gas Lgt—July 28, 1903. No. 57108 A.

The Way of Improvement in Coal Carbonization. Comment on the new systems of carbonization and new proposals for improvements of methods and appliances. 2300 w. Jour Gas Lgt—July 21, 1903. No. 56878 A.

Chandeliers.

Improvement of the Chandelier for Gas and Electric Lighting. A Hallard. An illustrated article describing the "Surprise pendant," a chandelier especially designed by an English firm for the incandescent burner, which can be used at any height. 1500 w. Archt Rec—Aug., 1903. No. 56860 C.

Coal Gas.

Remarks Upon the Principles Involved in the Production of Gases from Coal, and Suggestions as to their Application in Future Developments. William Young. Read at meeting of the N. British Assn. of Gas Mgrs. Also general discussion 9000 w. Gas Wld—Aug. 1, 1903. No. 57111 A.

Coal Handling.

Coal and Coke Handling Plant at Dunfermline Gas Works. A Waddell. Read before the N. British Assn. of Gas Mgrs. Illustrates and describes a combination coal and coke plant, stating its capabilities Discussion. 3200 w. Gas Wld—Aug. 15, 1903. No. 57477 A.

Gas Coals.

The Valuation of Gas Coals. A paper read before the N. of England Inst. of Min. & Mech. Engrs., with the chief portions of the discussion. 2500 w. Gas Wld—July 25, 1903. No. 57014 A.

High Pressure.

High Pressure Gas Distribution. John A. Britton. Read before the Pacific Coast Gas Assn. Shows how high pressure gas may be utilized. 4000 w. Am Gas Lgt Jour—Aug. 17, 1903. No. 57249.

Incandescence.

Incandescent Lighting in Western Australia. W. G. Quicke. A report of the degree of success in the introduction of the Welsbach incandescent system, the difficulty in securing really good mantles, &c. 1000 w. Jour Gas Lgt—July 21, 1903. No. 56880 A.

Loss of Illuminating Power of Mantles while Burning. Alfred H. White and M. E. Mueller. Prepared for meeting of the Michigan Gas Assn. A study of the causes of deterioration of mantles while burning. 5000 w. Am Gas Lgt Jour—Aug. 3, 1903. No. 57058.

Liquid Air.

Liquid Air: Its Manufacture, Distillation into Commercial Oxygen and Nitrogen, and the Application of Oxygen in the Industries, Especially for Use in Connection with Illuminating Gas. G. A. Bobrick. Read before the Pacific Coast Gas Assn. Reviews the history of the liquefaction of gas and describes the processes, now employed in the manufacture of liquid air and its distillation. 4800 w. Am Gas Lgt Jour—Aug. 24, 1903. No. 57516.

Metal Protection.

The Practical Protection of Metal Surfaces in Gas Plants. L. P. Lowe. Read before the Pacific Coast Gas Assn. Considers the preservation of corrosive metal surfaces about gas plants, including buildings, machinery, gasholders, tanks, mains, pipes, &c. 5000 w. Am Gas Lgt Jour—Aug. 24, 1903. No. 57517.

Meters.

Prepayment Gas Apparatus. Dr. H. Aron. Abstract translation of a paper before the German Assn. of Gas & Water Engrs. Shows how important a factor these meters have become and discusses features of the mechanism. 1400 w. Jour Gas Lgt—July 28, 1903. N. 57109 A.

Mixer.

A Proportional Gas Mixer (Doseur-Mélangeur de Gaz). A. Binet. A form of duplex gas meter, so arranged that air and gas, or gas and acetylene may be mixed in pre-determined proportions. 1000 w. Génie Civil—July 25, 1903. No. 57312 D.

Monazite.

A Visit to the Monazite Sand Deposits of Brazil. Joseph Tysoe. An account of a recent visit to Brazil in the interests of the gas industry. 2300 w. Jour Gas Lgt—July 28, 1903. No. 57107 A.

The Fight for the Gas Industry for a Controlling Hand Over Monazite. On the importance of the monazite sand and thorium question to the gas industry, and Mr. J. Tysoe's mission to Brazil. 3000 w. Jour Gas Lgt—July 21, 1903. No. 56877 A.

Natural Gas.

Natural Gas in England. Inverness Watts. An account of the discovery and development. Ill. 1400 w. Cassier's Mag—Aug., 1903. No. 57283 B.

Oil Gas.

Manufacture and Employment of Gas from Heavy Oil in Germany. M. W. Scheihauer. From the *Jour. für Gasbeleuchtung*. Describes the gas-producing apparatus and the manufacture of the gas. 3400 w. Sci Am Sup—Aug. 15, 1903. No. 57197.

Pipes.

Wrought Pipe. Franklin Riffle. Read at meeting of Pacific Coast Gas Assn. Reviews the history and development of the pipe industry, giving tests made, and comparison of steel pipe and wrought iron pipe, etc. 8000 w. Am Gas Lgt Jour—Aug. 17, 1903. No. 57250.

"Producer" Gas.

Should Gas Companies and Corporations Vend "Producer" Gas? Discusses British legislation favorable to a Mond gas supply and the effect on the gas interests. 2300 w. Jour Gas Lgt—Aug. 11, 1903. Serial. 1st part. No. 57289 A.

Purification.

Quadrupling the Capacity of an Ordinary Purifier House at Very Small Cost. F. H. Shelton. Read before the Western Gas Assn. Suggests a simple and effective method of increasing the capacity at small expense. Ill. General discussion. 4000 w. Pro Age—Aug. 1, 1903. No. 57056.

The Purification of Gas from Sulphur. H. Leicester Greville. Discusses the purification from sulphur compounds other than sulphuretted hydrogen. 2400 w Jour Gas Lgt—Aug. 4, 1903. No. 57215 A.

Retorts.

Heat Conductivity of Gas Retorts. H. A. Wheeler. Read before the Western Gas Assn. Describes methods of testing to determine if different makes of gas retorts have different rates of transmitting heat, discussing results. General discussion. 3400 w. Pro Age—Aug. 1, 1903 No. 57055.

Settings.

I. Gaseous Firing at Waterford Gasworks. R. Bruce Anderson. II. The Progress of Regenerative Settings since 1880. William Dunn. Two papers read before the Irish Assn. of Gas Mgrs. and discussed together. The first gives an illustrated description of the settings. The second paper deals with regenerative furnaces as applied to heating gas retorts, showing that there has been practically no improvement in construction or results for the past twenty-three years. Ill. 11300 w. Gas Wld—Aug. 15, 1903. No. 57476 A.

Stoking Machinery.

A German Installation of West's Retort-Stoking Machinery. Illustrates and describes the reconstruction of the Crefeld gas-works, and the successful working of this machinery, as given in an address by Herr Salzenberg. 4500 w. Jour Gas Lgt—July 28, 1903. No. 57106 A.

Sulphate of Ammonia.

The Manufacture of Sulphate of Ammonia. George Keillor. Read before the N. Brtish Assn. of Gas Mgrs. Discusses whether it is profitable to manufacture sulphate of ammonia in small gas-works, deciding in the affirmative and giving suggestions. 8500 w. Gas Wld—Aug. 1, 1903. No. 57112 A.

Water Gas.

Water Gas Manufacture by the Kramers and Aarts Process. Abstract of a paper by Dr. Alph. Steger at a recent meeting of the German and Swiss Assns. of Gas & Water Engrs. Considers both the continuous and intermittent methods of producing simple water gas. 4200 w. Jour Gas Lgt—July 21, 1903. No. 56882 A.

Widnes.

Widnes Gas and Water Works. Isaac Carr. Read at a Dist. meeting of the Assn. of Munic. & Co. Engrs. Describes these two undertakings and reports results obtained. 3800 w. Jour Gas Lgt—July 28, 1903. No. 57110 A.

Winterthur.

The Enlargement of the City Gas Works of Winterthur, Switzerland (Die Erweiterung des Städtischen Gaswerkes Winterthur). A general illustrated description. 3000 w. Schweiz Bauzeitung —June 13, 1903. No. 56951 D.

Works.

The Gas Works at Mariendorf near Berlin (Die Gasanstalt in Mariendorf bei Berlin). E. Körting. General description of plant, including inclined retorts, coal and coke handling machinery, and gasholders. The capacity is 800,000 tons of coal per year. 4000 w. Zeitschr d Ver Deutscher Ing—July 25, 1903. No. 57304 D.

The New Gas-Works at Haarlem. An illustrated description based on the presidential address of J. Blom, before the Dutch Assn. of Gas Mgrs., and on a recent inspection of the works. 1500 w. Jour Gas Lgt—July 21, 1903. No. 56879 A.

Widnes Gas-Works. Isaac Carr. A detailed description by the engineer. 1600 w. Gas Wld—July 25, 1903. No. 57015 A.

INDUSTRIAL ECONOMY

Apprentices.

See Electrical Engineering, Generating Stations.

British Tariff.

British Iron and Steel and the Proposed Fiscal Tariff. States the arguments of those who believe that a preferential tariff is of first importance to the welfare of these industries. 2800 w. Ir Age—Aug. 20, 1903. No. 57286.

British Trade.

Free Trade and Protection from the Workman's Point of View. M. Maltman Barrie. A discussion of the value of Mr. Chamberlain's proposals to the British workman. 7200 w. Nineteenth Cent—Aug., 1903. No. 57248 D.

Coal Industry.

The Cheapening of Coal. F. E. Saward. Discusses features of the coal industry, the surplus of pea, buck, and rice sizes, and the effect on prices. Also the tendency of bituminous sizes. 1500 w. Ir Age—Aug. 20, 1903. No. 57285.

Education.

A Century's Progress in Engineering Education in the United States. Robert Heywood Fernald. Reviews the development of technical education from the earliest times. 9300 w. Jour Assn of Engng Socs—July, 1903. No. 57449 C.

Engineering English. T. J. Johnston. Criticism on the use of the English language by engineers. 2000 w. Trans Am Inst of Elec Engrs—July, 1903. No. 57416 D.

Proper Qualifications of Electrical Engineering School Graduates, from the Manufacturer's Standpoint. L. A. Osborne. Considers the more important and most noticeable qualities lacking in the average technical graduate. 1800 w. Trans Am Inst of Elec Engrs—July, 1903. No. 57412 D.

The Teaching of Physics to Engineering Students. W. S. Franklin. Suggestions and criticisms. 2000 w. Trans Am Inst of Elec Engrs—July, 1903. No. 57414 D.

Training an Artist in the Forces of Nature. E. H. Mullin. A discussion of the faults of present day technical education and its aims. 2800 w. Trans Am Inst of Elec Engrs—July, 1903. No. 57415 D.

German Syndicates.

German Syndicates and Their Influence. A report on German trade in 1902 by Mr. Oppenheimer, Consul for Frankfort-on-Main. 4000 w. Ir & Coal Trds Rev—Aug. 14, 1903. No. 57490 A.

Government Ownership.

Should the Government Own or Control the Railroads? E. C. Nettels. Also, E. Wentworth. Two papers discussing this subject, especially in its bearing on American conditions. 7000 w. Pro Iowa Ry Club—June 16, 1903. No. 57428.

Labor.

American and British Workmen. A comparison, discussing the behavior and surroundings and their effect. 4700 w. Engng—Aug. 14, 1903. Serial. 1st part. No. 57491 A.

A Permanent Labor Court of Appeals. Gives a statement of the present industrial situation and the unsatisfactory methods of adjusting difficulties, and discusses the scheme of the Building Trades Employers' Assn., in New York. 2000 w. Gunton's Mag—Aug., 1903. No. 56863.

A Project for a Capitalized Labor Organization. C. L. Redfield. Suggestions for the establishment of business relations between capitalized labor and capitalized employers, instead of the present conflicting conditions. 3000 w. Engineering Magazine—Sept., 1903. No. 57367 B.

The Building Trades Employers and the Unions. William English Walling. An explanation of the situation in New York City, comparing it with the Chicago lock-out of 1900. 2000 w. World's Work—Aug., 1903. No. 57073 C.

The Present Status of the American Labor Movement. John R. Commons. Discusses the question of organized labor and the recent disputes, and the future outlook. 3800 w. Rev of Revs—Aug., 1903. No. 57202 C.

The Union versus the Open Shop. Discusses the question of unionizing shops, and other demands made by union labor, the misuse of power, etc. 2800 w. Gunton's Mag—Aug., 1903. No. 56862.

Steel.

The Steel Situation in the States. Editorial discussion of the present situation as revealed in the annual report of the American Iron & Steel Assn., and of the danger of over-production and the effect it will have on British trade. 2400 w. Engng—July 4, 1903. No. 57023 A.

We supply copies of these articles. See page 157.

MARINE AND NAVAL ENGINEERING

Boat Lighting.

See Electrical Engineering, Illumination.

Boilers.

See Mechanical Engineering, Steam Engineering.

British Marine.

Britain's Supremacy on the Atlantic. Editorial on the Cunard Steamship Company's agreement with the government, and the German high-speed vessels. 3300 w. Engng—Aug. 7, 1903. No. 57236 A.

Cavitation.

Cavitation with Screw Ships. J. A. Normand. Translated from *Comptes Rendus*. A study of the action of screw propellers. 1500 w. Marine Engng—Aug., 1903. No. 56890 C.

Destroyers.

Contract Trial of the United States Torpedo-Boat Destroyers Lawrence and Macdonough. Walter Ball. Illustration and description of the vessels, with report of trial. 4800 w. Jour Am Soc of Nav Engrs—Aug., 1903. No. 57552 H.

Description and Trials of the U. S. Torpedo-Boat Destroyers Hopkins and Hull. Illustration, description, and account of trials. 15600 w. Jour Am Soc of Nav Engrs—Aug., 1903. No. 57553 H.

Education.

The Education of Naval Engineers for Future Needs. Charles H. Manning. Showing that changed conditions have made necessary changes in methods of training, giving suggestions of some needed reforms. 2800 w. Jour Am Soc of Nav Engrs—Aug., 1903. No. 57558 H.

Electric Power.

See Electrical Engineering, Power Applications.

Experiments.

Naval Engineering Research. Editorial on the United States' new naval engineering laboratory and its work. 2200 w. Engng—Aug. 14, 1903. No. 57496 A.

The Military Importance of Naval Engineering Experiments. George W. Melville. Emphasizes the importance of the work; discusses the establishment and equipment of the national experimental laboratory, and the advantages. General discussion. 12000 w. Pro Engrs' Club of Phila—July, 1903. No. 57457 D.

Graving Dock.

The New Graving Dock of the Kawasaki Dock-Yard Company, Kobe. An illustrated detailed description of the construction of a dock which accommodates vessels up to 5,000 tons. 4700 w. Engng—July 24, 1903. No. 57021 A.

Guns.

Making Big Guns. Lieut. Com. Albert Gleaves. Comments on the great advances in naval equipment, describing the making of modern large guns, and giving information concerning the results obtained with them. Ill. 4100 w. World's Work—Sept., 1903. No. 57563 C.

Houseboats.

The Houseboat for Summer Outings. Illustrated descriptions of recent types, some self-propelled. 1500 w. Marine Engng—Aug., 1903. No. 56894 C.

Lake Navigation.

Problems of Lake Transportation. Lieut. W. H. Frost. Shows the need of improvement on present methods and considers some subjects in navigation which all masters of vessels should understand, and suggests ways of instituting changes. 5000 w. Marine Rev—Aug. 6, 1903. No. 57136.

Launch Motors.

Modern American Launch Motors. W. P. Stephens. Reviews the history of the propulsion of small boats by steam, and the later developments resulting in the naphtha launch, the gas engines of various types, and the electric motor. Ill. 6000 w. Cassier's Mag—Aug., 1903. No. 57280 B.

The Petrol Racing Launch "Napier." Illustrated description. 2400 w. Auto Jour—Aug. 15, 1903. No. 57475 A.

Lifeboat.

A Steam Lifeboat. An illustrated description of a steam lifeboat, named the Princess of Wales, recently constructed for the Government authorities of the Isle of Mauritius. 1800 w. Engng—Aug. 14, 1903. No. 57492 A.

Monitors.

A Comparison of the Performances of the Monitors Arkansas, Florida, Nevada, and Wyoming. R. E. Carney. The chief points of difference in these vessels are in the character of boilers installed and the design of propellers fitted to the shafts 2500 w. Jour Am Soc of Nav Engrs—Aug., 1903. No. 57556 H.

Oil Fuel.

Ocean-Going, Oil-Burning Tug Dauntless. Illustrates and describes a vessel recently launched in San Francisco. Open-hearth steel is used throughout. 1000 w. Marine Engng—Aug., 1903. No. 56889 C.

Power.

Powering of Ships. Theodore Lucas.

Considers methods of determining the power needed for a vessel. 1300 w. Naut Gaz—Aug. 6, 1903. No. 57139.

Resistance.

Experiments on the Resistance of a Screw Steamer in Free Route. H. Enno van Gelder Translated from *Schiffbau.* An account of dock experiments to measure the reaction of the pressure of the propeller on he water at different speeds, made at Kinderdyk, with the steamer "Vlaardingen. Ill. 2000 w. Marine Engng—Aug., 1903. Serial. 1st part. No. 56892 C.

Rivet Holes.

Drilled Holes. A discussion of Mr. Yarrow's paper on "Drilled v. Punched Rivet Holes in the Hulls of Ships." 3000 w. Engr, Lond—July 24, 1903. No. 57026 A.

Sailing Vessels.

The Old American Sailing Packets and Clipper Ships. John H. Morrison. Brief review of these early vessels and their development to meet the conditions of the times. Ill. 1500 w. Naut Gaz—Aug. 6, 1903. No. 57140.

Screw Propellers.

A Problem Connected with the Screw Propeller. W. F. Durand. Gives a mathematical solution of the problem of determining the speed when the ship and propeller and turning moment on the shaft are given. Other problems are also considered. 3000 w. Jour Am Soc of Nav Engrs—Aug., 1903. No. 57560 A.

Screw Propulsion for Naval and Maritime Purposes. George Quick. A paper based on the study, observation and experience of many years. 8500 w. Jour Am Soc of Nav Engrs—Aug., 1903. No. 57551 H.

Shafting.

On Screw Shafts. John List. Read at the Engng. Con. of the Inst. of Civ. Engrs. Also discussion. Considers the wear or corrosion of shafting, and matters related. 2400 w. Marine Engng—Aug., 1903. No. 56888 C.

Shipwrecks.

Why Vessels Lose Their Bearings and Strand. John Maurice. On errors due to the use of the floating or patent log near land. 1000 w. Marine Rev—Aug. 20, 1903. No. 57509.

Steamships.

Fine Transatlantic Freighters. Brief description with illustrations of the "Mississippi" and the "Massachusetts." 700 w. Naut Gaz—Aug. 6, 1903. No. 57137.

New Steamer Calvin Austin, for the Eastern Steamship Company. Illustrates and describes a new vessel for the Boston-Portland service. 1500 w. Marine Engng—Aug., 1903. No. 56893 C.

Novel Ore Carrier. Illustrated description of the steamer Grangesberg, constructed by an English firm for the Baltic ore trade. She carries her own discharging gear with her. 1200 w. Marine Rev—Aug. 6, 1903. No. 57135.

Steamship Monroe of the Old Dominion Line. An illustrated detailed description of a recently completed vessel for service between New York and Norfolk. A steel screw steamer of the hurricane-deck type. 5500 w. Marine Engng—Aug., 1903. No. 56886 C.

The Baden Steamboat "Stadt Meersburg" (Der Badische Bodensee-Dampfer "Stadt Meersburg"). H. Courtin. An illustrated description of a new side-wheel boat for use on the Lake of Constance in connection with the service of the Baden State Railways. 3500 w. 1 plate. Zeitschr d Ver Deutscher Ing—July 18, 1903. No. 57300 D.

The Twin-Screw Steamship Kaiser Wilhelm II. (Der Doppelschraubendampfer Kaiser Wilhelm II.). W. Kaemmerer. A general illustrated description with numerous illustrations from working drawings of hull and engines. Two articles. 6000 w. 4 plates. Zeitschr d Ver Deutscher Ing—Aug. 1 and 8, 1903. No. 57306 each D.

Submarines.

Official Trials of the Submarine Boats Plunger, Porpoise, and Shark. Daniel S. Mahoney. An account of the trials. 6500 w. Jour Am Soc of Nav Engrs—Aug., 1903. No. 57559 H.

Tonnage.

Registered Tonnages and Their Relation to Fiscal Charges and Design. James Maxton. Read before the Inst. of Nav. Archts. Discusses the British tonnage laws, and the essentials of an equitable basis for the levying of dues. 3500 w. Engng—July 24, 1903. No. 57025 A.

Torpedo Boats.

Care of Torpedo Boats in Reserve. G. C. Davison. Showing that attention and operation are essential for efficient maintenance. 6500 w. Jour Am Soc of Nav Engrs—Aug., 1903. No. 57554 H.

Some Experiences with the U. S. Torpedo Boat Goldsborough. H. G. Leopold. Gives an account of the conditions which caused shipbuilders a loss of over $2,000,000, and the failure of three firms, with facts and information of the trials made to secure the maximum speed guaranteed by the contractors. The causes of the failure of the machinery, with illustrations. 8400 w. Jour Am Soc of Nav Engrs—Aug., 1903. No. 57555 H.

Towboats.

Towboats on Western Rivers. Illustrates and describes the towboats used on the Ohio and Mississippi rivers to transport coal. 900 w. Marine Engng—Aug., 1903. No. 56887 C.

Turbine Steamer.

New Cross-Channel Turbine Steamer. Consular report concerning the steamship "The Queen," with articles from the Parsons Marine Steam Turbine Co. 1400 w. U S Cons Repts, No. 1736—Aug. 29, 1903. No. 57565 D.

The Turbine Steamship "Queen" (Le Paquebot à Turbines "Queen"). A. Dumas. An illustrated description of the new Parsons turbine steamer on the Calais-Dover service. 1200 w. Génie Civil—Aug. 1, 1903. No. 57313 D.

Yachts.

The Fruits of Cup Racing. Winfield M. Thompson. An illustrated article reviewing the various cup defenders, and the races, and commenting on the material progress and the sentiment due to the sport. 7000 w. Rudder—Aug., 1903. No. 57000 C.

The Modern Racing Yacht as an Engineering Proposition. W. P. Stephens. Showing that the modern racing yacht is entirely a development of bridge design in structure, and of marine powering in propulsion. 3000 w. Engineering Magazine—Sept., 1903. No. 57363 B.

MECHANICAL ENGINEERING

AUTOMOBILES.

Alcohol Motors.

Theory of the Alcohol Motor. C. C. Longridge. Shows the advantages of the combined cool cycle and high compression, and the beneficial influence of water. 2000 w. Engr, Lond—Aug. 7, 1903. No 57240 A.

Carbureters.

Carbureter Troubles and Remedies. Considers forms of carbureters, the action, troubles and the remedies. 4000 w. Automobile—Aug. 22, 1903. No. 57507.

Gasoline Motors.

A Combined Exhaust-Valve and Igniter for Gasoline Motors. Illustrated description of a novel arrangement fitted to the motors of the Duryea gasoline automobiles. 1000 w. Sci Am Sup—Aug. 15, 1903. No. 57198.

Gordon-Bennett.

The Race as I Saw It. W. J. Morgan. An illustrated account of the Gordon-Bennett race in Ireland. 3300 w. Auto Mag—Aug., 1903. No. 56861 C.

Light Cars.

The Renault Light Cars. An illustrated detailed description. 1000 w. Autocar—Aug. 1, 1903. No. 57104 A.

Hill Climbing.

The Laffrey Hill Climb. An illustrated account of the trials and results, giving details of interest. 3000 w. Autocar—Aug. 15, 1903. No. 57474 A.

Locomotives.

Compound Road Locomotive. Illustrates and describes a machine shown at the Royal Agricultural Society's exhibition. 800 w. Engr, Lond—Aug. 7, 1903 No. 57241 A.

Lubrication.

Cylinder and Crankshaft Lubrication E. W. Walford. On the lubrication of motor-car engines, considering the oiling of the gudgeon pin, the supply of lubricant, and experiments with graphite. 1400 w. Autocar—Aug. 15, 1903. No. 57473 A.

Mercedes.

The 1903 Mercedes Models. An illustrated detailed description. 2800 w. Auto Jour—Aug. 1, 1903. Serial. 1st part. No. 57103 A.

Municipal Vehicles.

The Use of Motor Vehicles for Municipal Purposes. Abstracts of two articles published in the *Contract Journal,* of London, giving an account of experience in their use in England. 4000 w. Eng News—Aug. 13, 1903. No. 57272.

Petrol Car.

The 1903 Oldsmobile Petrol Car. Illustrated detailed description of a small powered car to be sold at a moderate price. 3300 w. Auto Jour—Aug. 8, 1903. Serial. 1st part. No. 57217 A.

Speed.

Speed and Public Safety. Dr. Louis Bell. Considers problems in connection with the operation of automobiles and electric cars. 2500 w. Elec Rev, N. Y.—Aug. 15, 1903. No. 57255.

Standardization.

Standardization — Its Progress and What It Means to the Motorist. Considers its advantage to the owner and repairer, aid to repetition work, etc. 4000 w. Automobile—Aug. 8, 1903. No. 57102.

Steam Lurries.

The Invaluable Steam Lurry. Brief illustrated descriptions of modern vehicles of English make. 1700 w. Auto Jour—July 25, 1903. No. 57013 A.

The Musker Steam Motor-Wagon. Illustrated detailed description. 2200 w. Engng—Aug. 7, 1903. No. 57235 A.

Tool.

A Useful Combination Tool for Motorists. Illustrates and describes the Dalton combination tool, showing the detachabie parts separately and in different useful forms. 2000 w. Auto Jour—Aug. 8, 1903. No. 57218 A.

Touring.

How to Run a Rambler Touring Car. Extracts from a pamphlet, giving suggestions to the user of gasoline cars. Ill. 2200 w. Automobile—Aug. 22, 1903. Serial. 1st part. No. 57508.

HYDRAULICS.

Air Lift.

Air Lift Plant at the San Antonio Abad Cotton Mills in the City of Mexico. Juan Cuyas. Illustrated description, with results of tests. 1000 w. Compressed Air—Aug., 1903. No. 57201.

The Raising of Water from Deep Wells and Borings by Compressed Air. William H. Maxwell. Read at meeting of the British Assn. of Water-Wks. Engrs. The writer's views of the special circumstances to which this system is particularly applicable, reviewing the general principles governing the work, and giving details of the plant at Tunbridge Wells. 2700 w. Engr, Lond—Aug. 14, 1903. No. 57500 A.

Hydro-Electric Plants.

See Electrical Engineering, Generating Stations.

Plumbing.

I. The Art and Practice of Lead Burning by Aero-Hydrogen and Coal Gas. Charles Henry Mills. II. The Various Details of Work that Plumbers Have to Execute in and on a Large Size Dwelling-House. A. E. Edwards. Two prize essays which received the silver and bronze medals at the Regent-Street Polytechnic, London. Ill. 4000 w. Plumb & Dec—Aug. 1, 1903. No. 57169 A.

Screen.

Drift Screen on the Wien River at Weidlingau (Die Holzrechen-Anlage in den Hochwasserbehältern des Weinflusses bei Weidlingau). A. Swetz. Detailed description of the grating for the interception of drift and floating debris at the river protection works on the Wein near Weidlingau, Austria. 2500 w. Zeitschr d Oesterr Ing u Arch Ver—July 31, 1903. No. 57328 D.

Tanks.

Storage Tanks. The first of two articles illustrating and describing the most approved practice to meet varying conditions. 2000 w. Met Work—Aug. 22, 29, 1903. Serial. 2 parts. No. 57401.

Water Power.

See Electrical Engineering, Generating Stations.

Water-Wheels.

Tangential Water-Wheel Efficiencies. George J. Henry, Jr. An illustrated article discussing shapes of buckets, particularly the ellipsoidal as compared with the general form of the Pelton bucket. 4500 w. Engr, U S A—Aug. 15. 1903. No. 57252 C.

MACHINE WORKS AND FOUNDRIES.

Architecture.

Factory and Warehouse Architecture. A. K. Adler in Michigan *Technic*. The present article deals with the general planning and construction. 2500 w. Ir Trd Rev—Aug. 13, 20, 1903. 2 parts. No. 57243.

Blueprints.

A Rapid Blueprint Frame. John Randol. Illustrates and describes the blueprint frame invented by Charles H. Wills. 1200 w. Am Mach—Aug. 13, 1903. No. 57179.

Boring Mill.

Boring and Turning Mill for Electric Generators. Illustrates and describes a boring and turning lathe made for large dynamo work. 1200 w. Engng—Aug. 14, 1904. No. 57495 A.

Castings.

Castings in Modern Construction. D. Macdougal. A short paper on the making of steel castings. 900 w. Pro Engrs Soc of W Penn—June, 1903. No. 57463 D.

Fluxing Metals for Casting. Walter J. May. Suggestions and general information on the use of fluxes. 1500 w. Prac Engr—Aug. 7, 1903. No. 57221 A.

Porous Brass Castings. C. Vickers. Discusses the cause of leaky castings, and suggests means of remedying the trouble. 1700 w. Am Mach—Aug. 6, 1903. No. 57153.

Spelter Castings and Some Difficulties Encountered in Their Manufacture. Winslow Goodwin, in *The Metal Industry*. Discusses the question of why spelter is not more generally used. 2000 w. Foundry—Aug., 1903. No. 57432.

Coil Forming.

Universal Forming Machine for Armature Coils. H. Robinson. Illustrations showing a newly designed machine for forming armature coils to the required and proper shape for different sizes of armatures. 500 w. Am Mach—Aug. 20, 1903. No. 57288.

Coloring.

Coloring of Metals. From the French

of M. Paul Malherbe, in *La Revue des Produits Chemiques*. Describes processes of coloring by oxidation, and by sulphuration, with processes of deposit of a metal. 2300 w. Sci Am Sup—Aug. 8, 1903. No. 57172.

Cranes.

Notes on Crane Design—Load Brakes. A. D. Williams. Illustrates and describes several designs of load brakes. 2000 w. Am Mach—Aug. 20, 1903. No. 57287.

Cupolas.

Cupola Linings. Walter J. May, in the *Mechanical World*. An illustrated article referring to British cupola practice. 1800 w. Foundry—Aug., 1903. No. 57430.

Cutting Tools.

Cuting Tools for Planer and Lathe. W. J. Kaup. Abstract of a lecture delivered at Pratt Institute, Brooklyn. A discussion of important points in the use of these tools. Ill. 2500 w. Mach, N Y—Aug., 1903. No. 57079 C.

Electrical Works.

The Edison Interests at West Orange, N. J. An illustrated description of the extensive works where some of the inventions of Thomas A. Edison are manufactured. 2500 w. Elec Rev, N Y—Aug. 8, 1903. No. 57150.

The Schuckert Electric Works at Nuremberg, Germany. S. N. Taylor. An illustrated article describing these fine works and their equipment. 2200 w. Elec Wld & Engr—Aug. 1, 1903. No. 57089.

The Westinghouse Works, Manchester, G. R. Dunell. A finely illustrated article, giving detailed description of those fine engineering works and their equipment. Also gives particulars of some of the principal manufactures. 14500 w. Trac & Trans—Aug., 1903. No. 57211 E.

Electric Driving.

See Electrical Engineering, Power Applications.

Forgings.

Drop Forgings. Dwight Goddard. Explains the making of drop forgings. 2000 w. Pro Engrs Soc of W Penn—June, 1903. No. 57462 D.

Some Characteristics of Good Forgings and Some Things to Avoid. James H. Baker. 1200 w. Pro Engrs Soc of W Penn—June, 1903. No. 57461 D.

Steel Forgings. T. D. Lynch. Notes some of the characteristics of steel forgings. 1500 w. Pro Engrs' Soc of W Penn—June, 1903. No. 57460 D.

Gages.

Making Spherical End Gages. Charles W. Wright. Illustrates and describes inventions of the writer for grinding spherical end gages, and a lapping rig for gages. 900 w. Am Mach—Aug. 13, 1903. No. 57178.

Grinding Lathes.

Removing Stock in the Grinding Lathe. Henry Hess. Gives results of some competitive trials to determine the relative efficiency of two wheels. 2500 w. Am Mach—July 30, 1903. No. 56884.

Inspection.

Inspection and Quality of Product in Piece Work. Translated from the *Gewerblich-Technischer Ratgeber*. Describes methods of testing and forms of penalties for bad work. 2500 w. Am Mach—Aug. 13, 1903. No. 57180.

Locomotive Works.

Shops of the Locomotive & Machine Company of Montreal. Ilusturated detailed description of works with a capicity of about 300 locomotives a year. Also general business in machine and structural work. 1500 w. R R Gaz—Aug. 21, 1903. No. 57544.

The Tools and Methods of a Swiss Locomotive Works. C. R. King. An illustrated description of the Swiss Locomotive and Machine Works at Winterthur, showing the union of English, American, and Continental practice there found. 3500 w. Engineering Magazine—Sept., 1903. No. 57364 B.

Machine Shops.

The West Allis Plant of the Allis-Chalmers Company. An illusutrated detailed description of an important industrial plant and its operation. 2800 w. Eng Rec —Aug. 22, 1903. Serial. 1st part. No. 57527.

Mechanical Drawing.

Mechanical Drawing and Its Relation to Practical Shop Work. L. D. Burlingame. An address before the Eastern Manual Training Assn. Considers the drafting department as the interpreter *to* the shop, *of* the shop, and *for* the shop. 4000 w. Am Mach—July 30, 1903. No. 56885.

Railway Shops.

See Railway Engineering, Permanent Way and Buildings.

Shop Systems.

Shop and Sales Systems of the C. W. Hunt Co. John Calder. Charts and explanatory notes. 1200 w. Ir Trd Rev—Aug. 6, 1903. No. 57147.

Steel Castings.

The Small Converter for Steel Castings. Arthur Simonson. On the advantages of the small converter processes, especially for small castings. 2200 w. Ir Trd Rev—July 30, 1903. No. 56883.

Steel Construction.

Advance in Modern Steel Construction. L. F. W. Hildner. A short paper on the improved methods in shops where structural steel is made. 2000 w. Pro Engrs' Soc of W Penn—June, 1903. No. 57458 D.

Taps and Dies.

The Action of Taper Taps—Relieving Taps and Dies with Acid. Wolfra M. Fox. Suggestions from the experience of the writer. 1500 w. Am Mach—Aug. 6, 1903. No. 57155.

Tool-Boxes.

Wall Tool-Boxes. John Randol. An illustrated description of the Cowles' tool-box, showing its convenience. 2200 w. Am Mach—Aug. 6, 1903. No. 57154.

MATERIALS OF CONSTRUCTION.

Alloys.

The Light Aluminum Alloys. Dr. Joseph W. Richards. Read before the Am. Soc. of Test Materials. States the qualities of pure aluminum, and gives information in alloying with zinc, copper, nickel, magnesium, tilanium, tungsten, chromium, manganese and silver. 5500 w. Ir Age—Aug. 13, 1903. No. 57176.

Carborundum.

The History of Silicon Carbide (Zur Geschichte der Siliziumkarbide). Ed. Donath. A review of the historical development of compounds of silicon and carbon, showing that silicon carbide, or carborundum, was first described by Colson in 1882. Two articles, 3500 w. Oesterr Zeitschr f Berg u Hüttenwesen—Aug. 1, 8, 1903. No. 57335 each D.

Cast Iron.

A Microscopic Study of Cast Iron. Percy Longmuir. An examination of typical cast irons, reproducing characteristic structures, and giving notes on heat treatment for the production of "black heart" and malleable cast iron. 2700 w. Page's Mag—Aug., 1903. No. 57520 B.

Inspection.

Hints on the Inspection of Steel. Albert Moritz. Hints and suggestions of what is required of inspectors of material for the government. Gives methods of making tests, methods of manufacture, etc. 10800 w. Jour Am Soc of Nav Engrs —Aug., 1903. No. 57550 H.

Iron.

See Civil Engineering, Materials.

Metallography.

The Metallography of Iron and Steel. H. M. Howe. The first of a series of papers discussing the methods of investigating the real nature of the principal materials of construction by the methods of microscopical study. 4000 w. Engineering Magazine—Sept., 1903. No. 57361 B.

Nickel Steel.

Consequences of the Theory of Nickel Steels (Conséquences de la Théorie des Aciers au Nickel). C. E. Guillaume. A discussion of the possible relations of the peculiarities of nickel-steel alloys to the transformations in the state of the iron. 1000 w. Comptes Rendus—July 6, 1903. No. 57342 D.

High Grade Nickel Steels. The last chapter of a lengthy article by Mr. Dumas in the *Annales des Mines,* in which the author indicates the possible applications of the special steels. 6800 w. Bul International Ry Cong—July, 1903. No. 57444 E.

Nickel Steel for Purposes of Construction. Ralph H. Watson. Considers the properties that recommend this material, the uses to which it is applied, and gives tabulated results of tests. 2400 w. Pro Engrs' Soc of W Penn—June, 1903. No. 57459 D.

Nickel Steel: Its Properties and Applications. Albert Ladd Colby. Extract from a paper read at meeting of Am. Soc. for Test. Materials. Compares its physical properties with carbon steel, and gives information and general review. 4200 w. R R Gaz—Aug. 14, 1903. No. 57266.

The Theory of Nickel Steels (La Theorie des Aciers au Nickel). C. E. Guillaume. An exhaustive review of nickel-steel alloys, with especial reference to the magnetic and thermal properties, including the experiments of the author, as well as of Curie, Osmond, Le Chatelier, and others. Two articles, 10,000 w. Rev Gen des Sciences—July 15, 30, 1903. No. 57307 each D.

The Theory of Nickel Steel (Sur la Theorie des Aciers au Nickel). C. E. Guillaume. A classification of the thermal and magnetic properties of nickel-steel alloys with a view of establishing a theory for the observed phenomena. 1200 w. Comptes Rendus—June 29, 1903. No. 57339 D.

Pig Iron.

See Mining and Metallurgy, Iron and Steel.

Steel.

Cold Rolled Steel. J. J. Crane. Considers the properties of this material, and its treatment. 1500 w. Pro Engrs' Soc of W Penn—June, 1903. No. 57465 D.

Testing.

See Civil Engineering, Materials.

Tests.

Tests of Cast Steel Locomotive Parts on the Northern of France. M. du Bosquet. Translated from the *Revue Generale des Chemins de Fer.* Gives report of tests and results. 700 w. R R Gaz—July 31, 1903. No. 57046.

Tool Steels.

Notes on High-Speed Tool Steels.

Henry H. Suplee. Notes representing officially verified data of daily work. Ill. 1000 w. Inst Mech Engrs—July, 1903. No. 57125 D.

The New Tool Steel and Its Effect on Machine Shop Methods. Prof. C. I. King. Traces the development of tool steels, and the recent discovery which greatly increased the efficiency of the product, and results. 2500 w. Wis Engr—June, 1903. No. 57441 D.

MEASUREMENT.

Dynamometer.

A New Hydraulic Belt Dynamometer. Victor L. Sheldon. An illustrated detailed description of the machine, explaining principle upon which it is based and its use. 2000 w. Am Mach—Aug. 13, 1903. No. 57177.

Friction.

The Experimental Laws of Sliding Friction (Sur les Lois Experimentales du Frottement de Glissement). H. Chaumat. A mathematical discussion of the results of experiments upon the friction of polished discs, sliding without lubrication. 1200 w. Comptes Rendus—June 29, 1903. No. 57338 D.

Planimeter.

A New Integrating Planimeter, with a Proof of the Theory of Planimeters as Applied to the Integrating Pattern. Ill. 2000 w. Feilden's Mag—Aug., 1903. No. 57278 B.

Temperatures.

The Radiation Scale of Temperature and Its Realization up to 2,300 Degrees Absolute. O. Lummer and E. Pringsheim. From the *Berichte der Deutschen Physikalischen Gesellschaft*. Explanation of a new method of measuring high temperatures, giving experimental investigations made. 3000 w. Elect'n, Lond—Aug. 7, 1903. No. 57230 A.

Tension.

Tension Failure Phenomena, Their Meaning and Cause. Rudolph Hartman. Considers phenomena noted in tension tests, giving a list of the men who developed the "Theory of Elasticity" and the dates of their work. Ill. 12000 w. Wis Engr—June, 1903. No. 57440 D.

POWER AND TRANSMISSION.

Air Compressors.

The New Compressors of the Granby Company at Phoenix. George E. Cole. An illustrated detailed description of a recent installation in British Columbia. 1500 w. B C Min Rec—Aug., 1903. No. 57131 B.

Coal Handling.

See Gas Works Engineering.

Coal Hoist.

See Electrical Engineering, Power Applications.

Friction Clutch.

A New Form of Friction Clutch. Prof. H. S. Hele-Shaw. States the object of a friction clutch and the conditions involved, giving illustrated descriptions of various classes, and applications. 3700 w. Inst Mech Engrs—July, 1903. No. 57124 D.

Liquid Fuel.

See Mechanical Engineering, Steam Engineering.

Rope Driving.

Some Notes on Rope Driving. States the leading features of a rope drive and gives the most modern practice bearing upon these chief points. 1200 w. Prac Engr—July 31, 1903. No. 57114 A.

Ropeway.

A Wire Ropeway in the Anaimalai Hills. Horace H. Gass. Illustrates and describes a new ropeway for the transport of valuable lumber through inaccessible parts of Southern India. 3000 w. Page's Mag—Aug., 1903. No. 57523 B.

The Ore-Carrying Wire Ropeway at Vivero, Spain. Illustrates and describes an installation to convey iron-ore from the mines to the coast. 1500 w. Sci Am—Aug. 1, 1903. No. 57051.

Sources of Energy.

Natural sources of Energy. Dr. Louis Bell. Reviews the fuel situation, discussing other sources of power, and the probable extensive development of solar power in the future. 4500 w. Cassier's Mag—Aug., 1903. No. 57281 B.

SPECIAL MOTORS.

Alcohol Motors.

French Tests of Alcohol Motors. Capt. C. C. Longridge. Gives a table of the results with a view to indicating some method of comparison, and points of investigation. 1500 w. Engr, Lond—July 24, 1903. No. 57028 A.

See also Mechanical Engineering, Automobiles.

Diesel Motor.

An Oil Engine Central Station. Howard S. Knowlton. Illustrates and describes the new electric light plant at Jewett City, Conn., the first central station in the United States to adopt the Diesel oil-burning engine as its source of motive power. 1800 w. Am Elect'n—Aug., 1903. No. 57086.

Diesel.

The Diesel Engine. H. Ade Clark. A statement of principles and development, with account of performance of a motor at Harrogate in comparison with the steam engine. 6300 w. Inst Mech Engrs—July, 1903. No. 57122 D.

Gas Engines.

The Gas Engine and Its Future. Briefly reviews the history of gas engines, considering the details of the large-unit class and its applications, in order to determine its suitability for power stations and its present position. 1700 w. Elec Rev, Lond—Aug. 7, 1903. Serial. 1st part. No. 57226 A.

The Gas Engine as a Pumping Medium. D. Hastings Irwin. Presented at meeting of British Assn. of Water Works Engrs. Considers the internal combustion engine as a means of effecting economy in pumping. 3800 w. Jour Gas Lgt—Aug. 4, 1903. No. 57216 A.

Power Gas.

Mond Gas and Its Relation to Large Power Plants. H. G. H. Tarr. Revews the results thus far attained in connection with power plants. 1400 w. Engr, U. S. A.—Aug. 1, 1903. No. 57068 C.

STEAM ENGINEERING.

Binary Engines.

Large Waste Heat Engines. Franz Welz. Illustrates and describes the general scheme of such installations and discusses the advantages and disadvantages. 1800 w. Engr, U. S. A.—Aug. 1, 1903. No. 57066 C.

Blowing Engines.

Quarter-Crank Blowing Engines. Illustrations, with an explanation of the general design and scope of these engines. 1500 w. Engr, Lond—July 24, 1903. No. 57029 A.

Boiler Inspection.

Technical features of the Work of the Bavarian Boiler Inspection Society (Die Technischen Hauptergebnisse der Tätigkeit des Bayerischen Dampfkessel-Revisions-Vereines). J. Reischle & Chr. Eberle. A review of the society's reports, showing the influence of the data determined by boiler inspection upon steam boiler design. 8000 w. Zeitschr d Ver Deutscher Ing—July 18, 1903. No. 57302 D.

Boilers.

Size of Boilers. Charles L. Hubbard. Gives tables and data relating to the overall dimensions of various types of boilers. 2200 w. Engr, U. S. A.—Aug. 1, & 15. 1903. Serial. 2 parts. No. 57067 each C.

The Care of Locomotive Boilers. M. E. Wells. Second prize paper. On the damage boilers suffer from the lack of proper care. General discussion. 13700 w. Pro Pacific Coast Ry Club—July 18, 1903. No. 57426 C.

The Development of the Yarrow Boiler for Use in Battleships. William Crush. An illustrated article tracing the growth and development from 1887 to the present time. 3500 w. Jour Am Soc of Nav Engrs—Aug., 1903. No. 57557 H.

The Management and Working of Boilers. Horace Boot. Abstract of a paper read at the convention of the Incor. Munic. Elec. Assns., on the cleaning, inspection and testing of boilers, repairs, attention and general management. Based on experience at Tunbridge Wells. 4000 w. Mech Engr—July 25, 1903. No. 57016 A.

Condensing System.

The Reorganization of the Condensing System of the Manhattan Station. Explains why the system first installed was not satisfactory and gives an illustrated description of the changes made. The new apparatus has given satisfactory results. 1800 w. Power—Aug., 1903. No. 56865 C.

Engines.

Rebuilding an Engine. W. H. Wakeman. Describes details in connection with the repair of a second-hand engine. Ill. 2200 w. Engr, U. S. A.—Aug. 1, 1903. Serial. 1st part. No. 57070 C.

The Griffin Marine Type Hydro-Oil Engines. Illustrated, detailed description of two marine oil-engines having features of special interest. 1600 w. Engng—July 24, 1903. No. 57022 A.

The Westinghouse Vertical Marine Type Engine. An illustrated description of an engine designed to meet the requirements of the isolated plant at the Union Ry. Station at Pittsburg, Pa. 2700 w. Power—Aug., 1903. No. 56870 C.

Engine Testing.

A Few Points on Engine Testing. An interview with Mr. George H. Barrus. 3000 w. Engr, U. S. A.—Aug. 1, 1903. No. 57069 C.

Feed-Water.

Feed-Water Heaters. William Wallace Christie. Illustrates and describes examples from current American practice. 3000 w. Cassier's Mag—Aug., 1903. No. 57282 B.

Horse-Power.

Horse-Power of English and American Boilers, and Chimneys. George G. Bennett. Read before the Ohio Soc. of Mech, Elec. & Steam Engrs. Discusses past and present standards, boilers, efficiency of chimneys, and related subjects. 3800 w. Engr, U. S. A.—Aug. 15, 1903. No. 57-251 C.

Liquid Fuel.

Coal and Oil Fuel Compared. George E. Walsh. Considers the question of transportation in its bearing on fuel supply, and thinks oil will be more and more used. Discusses various sides of the fuel problem. 2300 w. Power—Aug., 1903. No. 56868 C.

Liquid Fuel. Illustrated detailed description of Kermode's system, stating its advantages. 2000 w. Engrs' Gaz—Aug., 1903. No. 57113 A.

Oil Burning Utilities and Futilities. Amanda T. Jones. The present article discusses the question of whether atomization previous to ignition is necessary, giving the writer's views. 3200 w. Steam Engng—Aug. 10, 1903. Serial. 1st part. No. 57144.

Pipe Coverings.

Experiments on the Efficiency of Non-Conducting Coverings for Steam Piping. W. N. Bolam and T. Grieve. An account of experiments carried out in the engineering laboratory of Edinburgh University, with summary of results. 1500 w. Engng—Aug. 7, 1903. No. 57234 A.

Power Plants.

Mechanical Plant in the Newark, N. J., Free Public Library. Illustrates and describes plant for furnishing light, heat and ventilation, power for elevators, book lifts, &c. 2000 w. Elec Rev, N. Y.—Aug. 15, 1903. No. 57256.

Power Plant Design. R. W. Stovei. Calls attention to details of plants, considering the requirements, and the apparatus usually installed. 5000 w. Pro Engrs' Soc of W Penn—June, 1903. No. 57466 D.

Power Plant of the Snellenburg Building. Walter Lewis Fleisher. Illustrates and describes the plant of a Philadelphia department store where peculiar conditions were imposed by the enlargement of the building. 2700 w. Steam Engng—Aug. 10, 1903. No. 57143.

Pulverized Coal.

The Burning of Pulverized Coal. C. O. Bartlett. Considers the requisites of success and the cost of securing them, and the advantages. 1800 w. Jour Assn of Engng Socs—July, 1903. No. 57452 C.

Regulators.

Regulators for Low Pressure Steam-Heating (Die Regulatoren für Niederdruck Dampfheizungen). E. Ritt. Illustrating a variety of automatic devices for controlling the steam pressure by regulating combustion. 2000 w. Gesundheits-Ingenieur—July 31, 1903. No. 57333 B.

Separators.

Internal Separators for Steam Boilers. R. T. Strohm. Illustrates and describes various devices for drying the steam, discussing their advantages and disadvantages 1800 w. Am Electrn—Aug., 1903. No. 57085.

Steam Shovels.

Improvements in Steam Shovels. Waldon Fawcett. Notes the increase in the capacities and other phases of the development. Ill. 2200 w. Sci Am—Aug. 1, 1903. No. 57050.

Stuffing Box.

The Schwabe Stuffing Box (Die Schwabe-Stopfbüchse). J. Finkle. Describing an improved metallic packing for piston-rod stuffing boxes, with a method of testing the efficiency by use of the indicator. 1200 w. Zeitschr d Ver Deutscher Ing—July 18, 1903. No. 57303 D.

Superheating.

A Contribution to the Study of Superheating (Contribution à l'Etude de la Surchauffe). A. Petot. A discussion of the formulas for superheated steam, showing the necessity for a more satisfactory determination of the specific heat at various temperatures. 1200 w. Comptes Rendus—July 20, 1903. No. 57343 D.

Mechanical Features in the Use of Superheated Steam. Editorial pointing out some of the relations of superheated steam to mechanical details in stationary and locomotive engines and boilers. 2000 w. Ry Age—Aug. 14, 1903. No. 57245.

The Cruse Controllable Superheater. Illustrates and describes a superheater which claims to have solved the difficulties found in other types. 2400 w. Engng —Aug. 14, 1903. No. 57494 A.

The Present State of the Theory of Superheated Steam (Etat Actuel de la Theorie de la Surchauffe de la Vapeur). H. Bernard. A review of the formulas of Witz, Poincaré and Rupprecht for computing the economy due to various degrees of superheating. 2000 w. Genie Civil—July 25, 1903. No. 57311 D.

MISCELLANY.

Aeronautics.

Dynamic Flying Machines. Herr W. Kress. Abstract of a paper read before the Aeronautical Congress. 1000 w. Autocar—Aug. 1, 1903. No. 57105 A.

Disinfection.

Disinfection by Steam (Ueber Dampfdesinfekteon). Drs. Kister and Weichardt. Advantages and disadvantages of superheated steam for disinfection and sterilization of clothing and other materials. Diagrams and tables. Serial. 2 parts. 2500 w. Gesundheits Ing—June 30 and July 10, 1903. No. 56947 B.

Farm Machinery.

The Revolution of Farm Machinery W. B. Thornton. An illustrated article showing the great progress made in farm machinery and the changes in agricultural methods. 3000 w. World's Work—Aug., 1903. No. 57072 C.

Heating.

The Brückner System of Rapid Circulation Heating (Neue Schnellumlaufheizung System Bruckner). J. Einbeck. Describing a system of hot-water heating in which the circulation is accelerated by the use of a steam jet. 2500 w. Gesundheits Ingenieur—July 20, 1903. No. 57331 B.

Loom.

The New Automatic Hattersley Loom. Illustrates and describes a loom claiming to be perfectly automatic or self-feeding in regard to the weft yarn. Gives information concerning its operation. 1800 w. Sci Am Sup—Aug. 8, 1903. No. 57171.

Protection.

On the Preservation of Instruments and Machinery in Bengal. Paul Bruhl. Read before the Calcutta section of the Inst. of Elec. Engrs. On the preservation of machinery in hot and moist climates, considering the adverse influences. 4000 w. Engr, Lond—July 24, 1903. Serial 1st part. No. 57031 A.

Refrigeration.

The Scientific Results of the Munich Refrigeration Investigation Station (Die Wissenschaftlichen Ergebnisse der Münchener Kälte-Versuchstation). C. Linde. A review of tests of various ice machines, of liquid air and of special researches made from 1893 to 1900. 4000 w. Zeitschr d Ver Deutscher Ing—July 25, 1903. No. 57305 D.

MINING AND METALLURGY

COAL AND COKE.

Alaska.

The Kayak Coal and Oil Fields of Alaska. P. C. Stoess. Locates the district, describing the formations and deposits. 2000 w. Min & Sci Pr—Aug. 1, 1903. No. 57146.

Briquettes.

Fuel Briquetting. Considers the materials which may be used, the extent of the industry and methods and machinery used in Europe and Canada. Ill. 6500 w. Mines & Min—Aug., 1903. No. 57004 C.

The Briquette Industry in France. Ed. Loze. Notes giving a general idea of the industry. 1400 w. Eng & Min Jour—Aug. 22, 1903. Serial. 1st part. No. 57535.

Coal Industry.

See Industrial Economics.

Heating Value.

The Relative Values of Coals and How to Burn Them. Jay M. Whitman. Gives information of capacities of various fuels measured in steam output, and suggestions for firing. 1200 w. Power—Aug., 1903. No. 56869 C.

Origin.

Some New Views on the Origin of Coal and Its Spontaneous Combustion, as well as on Firedamp Explosions (Einiges Neue über die Entstehung der Mineralkohlen und Ihre Selbstentzündung, sowie über die Schlagwetterexplosionen). F. Janda. A paleontological and chemical discussion. 5 parts. 10,000 w. Oesterr Zeitschr f Berg u Hüttenwesen—June 13, 20, 27, July 4 and 11, 1903. No. 56949 each D.

Thick Seams.

Working a Thick Coal Seam in Bengal, India. Thomas Adamson. Describes a method by which it is claimed that ninety per cent. of the coal is obtained. Ill. 2400 w. Mines & Min—Aug., 1903. No. 57006 C.

Washing Plants.

Coal Washing and Screening Plants. Illustrates and describes the Baum System and its working. 3800 w. Ir & Coal Trds Rev—July 24, 1903. No. 57035 A.

COPPER.

British Columbia.

See Mining and Metallurgy, Gold and Silver.

Concentration.

The Elmore Oil Concentration Plant. Arthur W. Sancton. Plan and description of the method and machinery used in concentrating copper ores at St. David's Mine, North Wales. 3000 w. Mines & Min—Aug., 1903. No. 57003 C.

Production.

World's Copper Production. A report of the last year's production in the various countries, comparing with the year previous. 1800 w. Engr, Lond—Aug. 7, 1903. 57242 A.

Queensland.

Mining in Northwest Queensland. Reginald A. F. Murray. Describes the formation, ores, &c., giving brief reports of some of the mines. The principal ores are silver, lead and copper. 1500 w. Aust Min Stand—July 2, 1903. Serial. 1st part. No. 57214 B.

Smelting.

Reverberatory Furnaces for Smelting

Copper. E. P. Mathewson. Brief illustrated description of the plant of the Washoe Copper Co., at Anaconda, Mont. 1100 w. Eng & Min Jour—Aug. 1, 1903. No. 57077.

GOLD AND SILVER.

British Columbia.

Boundary District of British Columbia. E. Jacobs. Information relative to the mines producing gold, silver, and copper ores. Ill. 4000 w. Eng & Min Jour—Aug. 22, 1903. No. 57533.

The Ore Deposits of Rossland, British Columbia. Bernard MacDonald. An illustrated description of this district, which is a large producer of gold-copper ore, and a study of the deposits. 2500 w. Eng & Min Jour—Aug. 8, 1903. No. 57184.

Canadian Practice.

Gold and Arsenic Recovery from Mispickel Ores. P. Kirkegaard. Describes the method of operation in a Canadian mill built with mortars suitable for inside amalgamation. 90 per cent. of the original gold was recovered. Also briefly describes the process of recovering the arsenic. 1000 w. Pacific C Min—Aug. 15, 1903. No. 57502.

Cyanide.

The Manufacture and Impurities of Commercial Cyandine. Alfred H. Allen. An important article explaining manner of detecting impurities. 1700 w. Eng & Min Jour—Aug. 15, 1903. No. 57264.

Use of Alkalies in the Cyanide Process. Ernest G. Sweetland. On the importance of using alkalies to overcome the effects of the acid, the methods of determining the amount necessary to add to the tailings, the merits of different alkalies, &c. 1000 w. Min & Sci Pr—July 25, 1903. No. 57065.

Determination.

The Iodometric Determination of Gold in Dilute Solution. Ralph N. Maxson Gives results of experimental investigations. 1800 w. Am Jour of Sci—Aug., 1903. No. 57433 D.

Ecuador.

Gold Mining and Milling in Ecuador J. W. Mercer. Gives experience in the treatment of peculiar ores, describing mines, methods, &c. 3000 w. Eng & Min Jour—Aug. 15, 1903. No. 57262.

Mexico.

The Santa Eulalia District, Mexico. Robert T. Hill. An illustrated article giving the history, geology, and a detailed description of the development of these silver-lead mines. 3600 w. Eng & Min Jour—Aug. 1, 1903. No. 57075.

The Yaqui River Country of Sonora, Mexico. George J. Bancroft. An illustrated description of this district which is essentially a silver mining country, and of the country and mining conditions. 2700 w. Eng & Min Jour—Aug. 1, 1903. No. 57076.

Mother Lode.

The Banner Country of the Mother Lode. J. L. Bentley. Notes of present conditions in Amador County, California. Ill. 1800 w. Pacific C Min—Aug. 1, 1903. No. 57099.

New Mexico.

The Oregon Mining District. F. H. Lerchen. An illustrated description of the region, with special reference to the Modoc mine, N. Mexico. The ores are lead-silver and copper-silver. 2400 w. Mines & Min—Aug., 1903. No. 57001 C.

Ore Treatment.

The Treatment of Sulpho-Telluride Ores at Kalgoorlie. W. A. Pritchard and H. C. Hoover. Describes the treatment of refractory ores by the Diehl Process, and by the Roasting Process, comparing the results. 2500 w. Eng & Min Jour—Aug. 1, 1903. No. 57074.

Placers.

Placer Mining in Southern Oregon. Dennis H. Stovall. An illustrated account of the hydraulic mines and their methods. 1000 w. Min & Sci Pr—Aug. 15, 1903. No. 57515.

Rock Crushing.

I. A System of Crushing Rock in Stages by Wet Process and Suggestions as to How this Object Can Best be Achieved. Edward D. Chester.

II. A Further System of Crushing Rock in Two Stages, by Dry Process, with High-Class Cross-Grinding Rolls. Wegerif Type. Two papers with discussion. Ill. 7400 w. Jour Chem & Met Soc of S Africa—June, 1903. No. 57220 E.

Slimes.

The Desulphurization of Slimes by Heap Roasting at Broken Hill. E. J. Horwood. Abstract from *Trans.* of the Australian Inst. of Min. Engrs. Describes the ores and the treatment given. 2700 w. Eng & Min Jour—Aug. 22, 1903. No. 57532.

Stamp Mills.

New Method of Feeding Water to the Battery. Bernard MacDonald. Describes a novel method of introducing the feed water into the mortar of the stamp mill. Ill. 1500 w. Pacific C Min—Aug. 1, 1903. No. 57098.

Sulphides.

The Treatment of Broken Hill Sulphides. Alec A. Beadle. Considers the complex sulphide ores in which lead, zinc and silver constitute the most important ingredients. 1800 w. Eng & Min Jour—Aug. 8, 1903. No. 57182.

Victoria.

The Charlotte Plains Consolidated Gold Mines Company. An illustrated description of the plant, report of progress, &c. 2300 w. Aust Min Stand—June 18, 1903. No. 57011 B.

Yukon.

White Horse District, in Yukon Territory. William M. Brewer. Reviews the history, geology, present conditions, and future prospects of the mining industry. Map and editorial. 5500 w. Mines & Min—Aug., 1903. No. 57007 C.

IRON AND STEEL.

Blast-Furnace Gas.

The Utilization of Blast-Furnace Gases for Power Purposes. Charles Kirchhoff. Traces the development of the gas engine and discusses the use of waste furnace gas, presenting some of the principal engine designs. Ill. 4000 w. Jour Fr Inst—Aug., 1903. No. 57436 D.

Blast Furnaces.

Blast Furnace Capacity Rapidly Increasing. Information given by the American Iron & Steel Assn., showing that blast furnaces are to be increased 2,000,000 tons the present year, and 2,500,000 tons next year. 2000 w. Ir Age—Aug. 27, 1903. No. 57562.

Temperature Reactions in the Blast Furnace. Horace Allen. Gives diagram showing the variations which occur, with notes. 800 w. Engr, Lond—July 24, 1903. No. 57027 A.

Blowing Engines.

See Mechanical Engineering, Steam Engineering.

Cast Iron.

See Mechanical Engineering, Materials.

Coke Ovens.

Beehive Coke Ovens. Gives plans, specifications, and costs of ovens as constructed recently in Indiana Co., Pa. 1700 w. Mines & Min—Aug., 1903. No. 57002 C.

Elba.

The Iron Industry on the Island of Elba (Die Eisenindustrie auf der Insel Elba) Fr. Poech. An account of the iron mines and furnaces. Map and geological sections. 4000 w. Oesterr Zeitschr f Berg- u Hüttenwesen—July 4, 1903. No. 56950 D.

Limonites.

Origin of the Oriskany Limonites. J. E. Johnson, Jr. A record of facts and observations taken principally from the Virginia brown ore fields, giving an explanation of the occurrence of these ores. 3000 w. Eng & Min Jour—Aug. 15, 1903. No. 57261.

Mesabi.

Notes on Recent Work on the Mesabi Iron Range. Dwight E. Woodbridge. Information concerning the exploration work on this range. 1000 w. Eng & Min Jour—Aug. 8, 1903. No. 57186.

Ores.

Iron Ores of Arctic Lapland. Chase S. Osborn. From a paper read before the Lake Superior Min. Inst. Describes the mines, methods of mining, extent of deposits and their character, giving information about cost, transportation and related matters. 4000 w. Ir Trd Rev—Aug. 20, 1903. No. 57512.

The Iron Ore Deposits of Lorraine (Das Lothringsche Eisenerzlager). Dr. O. Lang. A geological study of the important ore deposits of the district, showing the extensive developments of the last decade. Two articles. 3 plates. 7000 w. Glückauf—July 11, 18, 1903. No. 57336 each D.

Pig Iron.

How to Determine the Quality of Pig Iron. S. B. Patterson. Read before the New England Found. Assn. Considers the influences exerted by the ordinary elements and treatment. 3500 w. Foundry—Aug., 1903. No. 57431.

Smelting.

Considerations Favorable to Hot-Blast Smelting. Abstract from a pamphlet issued by the Colorado Iron Works Co., dealing with details of smelting practice and equipment. 2500 w. Min & Sci Pr—Aug. 15, 1903. No. 57514.

Steel.

See Mechanical Engineering, Materials.

Steel Castings.

See Mechanical Engineering, Machine Works and Foundries.

Steel Making.

See Electrical Engineering, Electro-Chemistry.

Steel Trade.

See Industrial Economy.

MINING.

Dredge Mining.

Dredge Mining in British Columbia. William M. Brewer. Discusses briefly the causes of the unsatisfactory results obtained. 1500 w. B C Min Rec—Aug., 1903. No. 57132 B.

Drilling.

Oil Well Drilling. An illustrated description of a fine drilling outfit and a synopsis of its operations. 3000 w. Met Work—Aug. 8, 1903. No. 57061.

Electric Hoisting.

See Electrical Engineering, Power Applications.

Electric Power.

See Electrical Engineering, Power Applications.

Filling.

New Methods of Filling in the Goaf in Germany. From the report of Herr Williger, printed in the Report of the Prussian Commission on the Fall of Stone and Coal in Mines. Illustrates and describes the methods used, stating the advantages and difficulties and giving information of interest 6000 w. Ir & Coal Trds Rev—Aug. 7, 1903. No. 57233 A.

Fires

· Underground Fires. F. W. Hardwick. Read before the International Fire Prevention Congress. Discusses the dangers, causes and means of prevention of mine fires. 5700 w. Col Guard—July 31, 1903. No. 57120 A.

Hoisting.

Some Notes on Certain Underground Hoisting Problems on the Witwatersrand. A. W. K. Peirce. A general statement of the conditions, concluding that the best method is the combination of poly-phase transmission, concession to direct currents for each hoist unit, and the "voltage control" of Leonard system. 2200 w. Trans Am Inst of Elec Engrs—July, 1903. No. 57402 D.

Igneous Rocks.

Igneous Rocks: How to Identify Them Charles J. O'Brien. Describes the more common igneous rocks, giving practical hints for identifying them without microscopical examination. 1800 w. Min & Sci Pr—July 25, 1903. No. 57063.

Improved Appliances.

Improved Appliances, &c., Introduced Into German Mines in 1902. From *Zeitschrift für Berg-Hütten- und Salinenwesen.* Illustrated descriptions. 1400 w. Col Guard—Aug. 14, 1903. Serial. 1st part. No. 57488 A.

Management.

Real Values in Mine Management. Charles H. Fitch. Discusses some considerations by which management can be judged. 2000 w. Min & Sci Pr—Aug. 8, 1903. No. 57244.

Mexico.

From Parral to Guadaloupe y Calvo, Chihuahua, Mexico. H. Z. Osborne. An interesting account of a mule-back trip through this mineral district. Ill. 2800 w. Min & Sci Pr—July 25, 1903. No. 57064.

Mine Gases.

Some Mine Gases: Their Toxicology and Possible Connection with Miners' Phthisis. A. Heymann. Discusses the effects of higher oxides of nitrogen and carbon monoxide. 5800 w. Jour Chem & Met Soc of S Africa—June, 1903. No. 57219 E.

Mine Locomotives.

Pneumatic and Electric Locomotives in and about Coal Mines. A. S. E. Ackermann. Abstract of paper read before the Inst. of Min. Engrs. Brief comparison of the working of the two systems. 1200 w. Elect'n, Lond—Aug. 14, 1903. No. 57486 A.

Mine Plans.

Mine Plans, Their Preparation and Use. J. D. Kendall. Read before the Inst. of Min. & Met. The present article discusses the preparation of plans and what they should show. 1700 w. Min Rept—Aug 20, 1903. Serial. 1st part. No. 57505.

Mine Water.

Water in the Mines of Cripple Creek. Victor G. Hills. Describes the distribution of water in the mines of this district. A valuable contribution to the data covering the occurrence of water in veins. 3300 w. Eng & Min Jour—Aug. 8, 1903. No. 57183.

Ores.

Pisolitic and Concretionary Ores. A Selwyn Brown. Describes the peculiarities of these ores of iron, aluminum, nickel, manganese, etc., and gives explanations of their origin; gives also brief descriptions of deposits at various places. 3500 w. Aust Min Stand—June 18 & 25, 1903. Serial. 2 parts. No. 57012 each B.

Prospecting.

Prospecting and Valuing Dredging Ground with a Well Driller at Oroville, Cal. Newton Booth Knox. Slightly condensed from a paper read before the Inst. of Min. & Met. Gives briefly the history of this region and describes the operation of drilling, treatment, and calculating the values. 2500 w. Eng News—July 30, 1903. No. 57038.

Safety Apparatus.

Safety Apparatus for Underlie Shafts. Report on a fatal accident at Ravenswood (Queensland) with illustrated description of two simple appliances to prevent trucks from running away. 1800 w. Queens Gov Min Jour—June 15, 1903. No. 56-875 B.

Safety Lamps.

Safety Mining Lamps. Rufus J. Foster. Reviews the history of mine lighting from the earliest times, and the development of the Davy lamp, and the lamps of other inventors. Ill. 6200 w. Jour Fr Inst—Aug., 1903. No. 57437 D.

South Africa.

The Equipment of the Robinson Mine. Johannesburg. Edgar Smart. Discusses notable features of one of the largest mines in the Rand. Ill. 3800 w. Page's Mag—Aug., 1903. Serial. 1st part. No. 57521 B.

Veins.

Cross-Vein Ore-Shoots and Fractures. W. H. Weed. Describes and explains the manner of formation. 900 w. Eng & Min Jour—Aug. 8, 1903. No. 57181.

Hydro-Thermal Activity in the Veins at Wedekind, Nevada. Henry C. Morris. Gives a general description of the mines and the encounter with warm water heavily charged with sulphureted hydrogen, discussing the ore occurrence. Ill. 2700 w. Eng & Min Jour—Aug. 22, 1903. No. 57534.

Secondary Enrichment of Mineral Veins in Regions of Small Erosion. C. L. Herrick. Presents views of the writer, based on wide observation and study explaining the cause of the wide difference in the reliability of gold-bearing veins found in two parts of the same range. 2000 w. Min & Sci Pr—Aug. 15, 1903. No.57513.

MISCELLANY.

By-Products.

By-Products from Gas, Coke, and Pig Iron Manufacture. Information from the report of R. Forbes Carpenter. 2500 w. Col Guard—Aug. 7, 1903. No. 57232 A.

Diamonds.

Kimberley Notes. T. Lane Carter. Illustrated article containing information of interest concerning these important diamond mines. 3700 w. Eng & Min Jour—Aug. 15, 1903. No. 57263.

Geology.

The Sea and Mining. Prof. Arthur Lakes. Illustrations shown at the sea coast of manner of making and destruction of rocks by action of shell-fish and erosion. 2400 w. Mines & Min—Aug., 1903. No. 57005 C.

Mica.

Mica in Brazil. H. Kilburn Scott. Read before the Inst. of Min. & Met. Discusses its varieties, its uses, where it is obtained, and a description of the deposits and mines of Brazil. 5000 w. Mines & Min—Aug., 1903. No. 57009 C.

Quicksilver.

The Cinnabar Fields of Texas. David DeWitt Lawrence. An illustrated account of the Terlingua district and its development. 2000 w. Min Rept—Aug. 20, 1903. No. 57504.

Sapphires.

The Anakie Sapphire Fields. B. Dunstan. Information from the annual progress report of the acting-government geologist. Ill. 1500 w. Queens Gov Min Jour—June 15, 1903. No. 56874 B.

Separation.

The Separation of Vanadium, Uranium, and Radium from Carnotite. Dr. J. Ohly. Describes the treatment for the recovery of vanadium, radium, and uranium values. 1600 w. Min Rept—Aug. 6, 1903. No. 57101.

See Electrical Engineering, Electrochemistry.

Volcanoes.

Mud Volcanoes. Prof. Arthur Lakes. On present-day illustrations of mud flows and formations resembling some older ones in which mineral deposits have been found. Ill. 1000 w. Mines & Min—Aug., 1903. No. 57008 C.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

Accidents.

Government Accident Bulletin No. 7. Substance of the seventh quarterly accident report of the Interstate Commerce Commission, with editorial. 2800 w. R R Gaz—July 31, 1903. No. 57048.

Express Scheme.

An All Stations Express Train. Diagrams and description of a scheme for obviating the stopping of local trains, devised by Prof. J. Brown. 1500 w. Sci Am Sup—Aug. 15, 1903. No. 57196.

Fast Runs.

Record Runs Between London and Brighton. Charles Rous-Marten. A report of test runs made to show that the trips could be made in 50 minutes, the time being really less than that. 1800 w. Engr, Lond—July 31, 1903. No. 57128 A.

The Great Western's Royal "Record" Run. Charles Rous-Marten. Gives details of what is claimed as the most remarkable run on record. 2700 w. Engr, Lond—Aug. 14, 1903. No. 57499 A.

Train Dispatching.

The Expert Train Dispatcher. From the *N. Y. Times*. An explanation of the work and great responsibility carried by the dispatcher. 2300 w. Sci Am Sup—Aug. 22, 1903. No. 57296.

MOTIVE POWER AND EQUIPMENT.

Air Brakes.

Air-Brakes on Mountain Grades. Extracts of interest, from a pamphlet of the

Interstate Commerce Commission, showing the diversity of practice on different roads. 1500 w. R R Gaz—Aug. 7, 1903. No. 57163.

Car Lighting.

See Electrical Engineering, Illumination.

Circulator.

Sheedy Circulator for Locomotive Cylinders. Indicator diagrams, illustrating the effect of the invention, and the conditions that exist in the cylinders when the circulator is not in use, with explanatory notes. 900 w. Loc Engng—Aug., 1903. No. 57057 C.

Electric Locomotives.

Electric Locomotives for the Baltimore Tunnel. Illustrated description of a distinct advance in electric locomotive design. 900 w. Ry Age—Aug. 21, 1903. No. 57510.

Electric Locomotives on French Railways. From *La Nature*. Illustrates and describes the types adopted by the Orleans line, and the line of the West, and discusses their advantages under certain conditions. 1700 w. Sci Am Sup—Aug. 15, 1903. No. 57199.

Locomotive Frames.

The Locomotive Steel Frame and Its Repairs. A. W. McCaslin. Considers the locomotive cast steel frame and its defects. General discussion. 7500 w. Pro Ry Club of Pittsburg—April, 1903. No. 57425 C.

Locomotives.

Atlantic Type (4-4-2) Locomotive for the Baltimore & Ohio. Illustrated description of engines for use on heavy and fast passenger trains. 500 w. R R Gaz—July 31, 1903. No. 57045.

Culm Burning Passenger Locomotives. Illustrated description, with dimensions, of an engine of the 4-6-0 type of the Deleware & Hudson Co. 350 w. Am Engr & R R Jour—Aug., 1903. No. 56872 C.

Duplex Tank Locomotive. Sectional drawings of an engine described in a previous issue. The engine constructed for the Compagnie de Chemins de Fer Departementaux, by La Société Suisse, of Winterthur. 200 w. Engr, Lond—Aug. 7, 1903. No. 57239 A.

Express Engine, Bengal-Nagpur Railway. Illustration and principal dimensions of a six-wheels coupled express passenger locomotive. 400 w. Engr, Lond—July 31, 1903. No. 57130 A.

European Four-Cylinder Compound Locomotives. Abstract of a paper by Prof. von Borries, translated from the *Zeitschrift des Vereins Deutscher Ingenieure*, with critical review by Lawford H. Fry. 2400 w. Ry Age—Aug. 7, 1903. No. 57141.

German Locomotive Designs for High Speed Service. Lawford H. Fry. Illustrations and tabulated comparison of four prize designs, and illustrated description of Prof. von Borries' train design. 1400 w. R R Gaz—Aug. 21, 1903. No. 57547.

Recent Locomotive Construction in Germany. Illustrations with brief descriptions of interesting examples of freight and passenger engines. 1200 w. Ry & Engng Rev—Aug. 8, 1903. No. 57188.

Some Recent High-Speed Locomotives (Neuere Schnellzuglokomotiven). M. Weiss. Illustrated descriptions, mainly of European compound locomotives. 2 parts. 1 plate. 3500 w. Schweiz Bauzeitung—June 20 and 27, 1903. No. 56-952 each D.

Locomotive Works.

See Mechanical Engineering, Machine Works and Foundries.

Main-Line-Traction.

See Street and Electric Railways.

Trucks.

Continental Types of High-Capacity Railway Trucks. From *Glückauf*. Illustrations, with brief descriptions. 500 w. Col. Guard—Aug. 7, 1903. No. 57231 A.

NEW PROJECTS.

Long Island R. R.

Atlantic Avenue Improvement on the Long Island Railroad. Outlines the future plans for this road, showing the importance of the removal of the surface tracks. Gives an illustrated description of the work. 1500 w. Ry Age—July 31, 1903. No. 57060.

Trans-Canadian.

The Grand Trunk Pacific Railway Legislation. Discusses notable features of the Grand Trunk Pacific bill, giving information in regard to the project. Also editorial. 3500 w. Ry Age—Aug. 7, 1903. No. 57142.

PERMANENT WAY AND FIXTURES.

Boston Station.

Back Bay Station, Boston; New York, New Haven & Hartford Railroad. Illustrates and describes a fine station built to serve the residential district. 2200 w. Ry & Engng Rev—Aug. 8, 1903. No. 57187.

Construction Cost.

The Cost of the Albula Railway (Die Kosten der Albulabahn). R. v. Reckenschuss. An abstract of the cost of the construction of the Albula railway in Switzerland, giving practical data as to the cost of Alpine railways. 2500 w. Zeitschr d Oesterr Ingn Arch Ver—June 28, 1903. No. 57325 D.

Grades.

Grade Reduction on the Illinois Central.

Reviews the changes in progress on the different divisions. Map. 2500 w. R R Gaz—Aug. 14, 1903. No. 57269.

Reduction of Grade on Railroads. C. D. Purdon. Discusses questions bearing on the reduction of grades to secure economy in operation. 3000 w. Jour Assn of Engng Socs—July, 1903. No. 57450 C.

Location.

Some Theories Upon Railroad Location. J. G. G. Kerry. Abstract of a paper read before the Canadian Soc. of Civ. Engrs. Considers preliminary work, grades, curvature, etc. 5700 w. Eng News—Aug. 20, 1903. No. 57543.

Locomotive Works.

See Mechanical Engineering, Machine Works and Foundries.

Long Island R. R.

Progress of the Atlantic Avenue Improvement of the Long Island Railroad. An illustrated article showing work, nearing completion, to get the tracks of this road off grade on Atlantic Ave., Brooklyn. 1700 w. R R Gaz—July 31, 1903. No. 57047.

Railroad Building.

Feats of Modern Railroad Engineering. Henry Harrison Lewis. An illustrated account of difficult work, tunneling mountains, bridging chasms, etc. 2000 w. World's Work—Sept., 1903. No. 57564 C.

Rebuilding.

The Rebuilding of the Gulf & Ship Island. An account of this road and its reconstruction, with plan, map and illustrations showing the general scheme of the work. 1700 w. R R Gaz—July 31, 1903. No. 57044.

Shops.

The New Rock Island Shops at East Moline, Ill. An illustrated detailed description of these shops and their equipment. 2500 w. Ry Age—Aug. 21, 1903. No. 57511.

The Renovo Shops—Pennsylvania Railroad. Illustrates and describes improvements made in these shops, so far as completed. 1700 w. Ry Age—Aug. 14, 1903. No. 57246.

The Southern Pacific Shops at East Los Angeles. General plan and description. 1400 w. R R Gaz—Aug. 14, 1903. No. 57268.

Signalling.

An Audible and Visible Railway Signal for Grade Crossings, Operated by a High Tension Current. Emile Guarini. Illustration and brief description of a new system introduced by Siemens & Halske. 300 w. Sci Am—Aug. 15, 1903. No. 57194.

Switches.

Electro-Pneumatic Switches. Describes the plant recently installed at Bayonne, N. J., for the Central R. R. of New Jersey, for operating interlocking switches. Ill. 1200 w. Compressed Air—Aug., 1903. No. 57200.

Should Frogs and Switches Be Blocked? G. E. McCaughan. Also, J. H. Maher. Two papers considering the question of blocking. 6500 w. Pro Iowa Ry Club—June 16, 1903. No. 57427.

Terminal Station.

New Terminal Station at Chicago for the C., R. I. & P. Ry. and the L. S. & M. S. Ry. Illustrated detailed description of a station in which the tracks are elevated above the street level. 5500 w Eng News—Aug. 6, 1903. No. 57159.

Ties.

Experiments with Steel and Reinforced Concrete Ties. Illustrates and describes the experiments made by C. Buhrer on the L. S. & M. S. Ry. and on other roads. 3000 w. Ry & Engng Rev—Aug. 1, 1903. No. 57062.

The Life of Treated Ties. Samuel M. Rowe. Abstract from a pamphlet on "The Value of Treatment of Timber." 900 w. R R Gaz—Aug. 21, 1903. No. 57548.

STREET AND ELECTRIC RAILWAYS

Acceleration.

High Acceleration on Electric Railways. Results on the Liverpool Overhead Line. Herbert C. Fyfe. On the satisfactory results from the accelerated service introduced. 1400 w. Sci Am Sup —Aug. 22, 1903. No. 57297.

Berlin.

Alterations in the Train Service on the Berlin Metropolitan Electric Railway and Extension of the Line. Mr. Kemmann. Points out the alterations that have been made in the service of the main line and gives particulars regarding the extension towards the center of the city. Map. 4300 w. Bul International Ry Cong—July, 1903. No. 57443 E.

Car Tests.

Interurban Car Tests. W. E. Goldsborough and P. E. Fansler. An illustrated account of car tests made on the cars of the Union Traction Company of Indiana.

10000 w. Trans Am Inst of Elec Engrs —July, 1903. No. 57411 D.

Construction.

Permanent Way Construction and Maintenance. Charles A. King. A summary of replies received to some seventy questions on track construction sent to different roads by the managers of the Glasgow tramways. 5000 w. St Ry Jour —Aug. 1, 1903. No. 57083 D.

Electric Locomotives.

See Railway Engng., Motive Power.

Electric Traction.

Mediterranean System of Electric Traction in the Neighborhood of Nice and Hydraulic Plant of Mesala. C. L. Durand. Brief illustrated description of one of the most extensive systems of electric traction in Europe. 2200 w. Elec Rev, N. Y.—Aug. 8, 1903. No. 57149.

Electrification.

Electric Traction on the North-Eastern Railway. An illustrated detailed account of the extent of the scheme and of the manner in which it will be carried out. 2300 w. Engr, Lond—July 24, 1903. No. 57030 A.

Glasgow Tramways.

Glasgow Municipal Tramway Results. Editorial review of the report for the year ending with last May. 1800 w. Engng —Aug. 7, 1903. No. 57237 A.

Goods Traffic.

Carriage of Merchandise on Electric Tramways. Thomas Upton. Discusses this service in England, the inter-working with the railways, rates, etc. 2200 w. Elec Rev, Lond—Aug. 14, 1903. Serial. 1st part. No. 57481 A.

High Speed.

High Speed Electric Railway Problems. A. H. Armstrong. Considers some of the relations existing between first cost and probable cost of operation and schedule speed, discussing also the probable traffic receipts with different methods of operation. 5000 w. Trans Am Inst of Elec Engrs—July, 1903. No. 57403 D.

High Speed Electric Railways. B. F. Bradford. Read before the Elec. Assn. of N. S. W. Considers some of the problems bearing upon the earning capacity and design of a projected interurban railway, and methods for their solution. 3700 w. Aust Min Stand—July 16, 1903. Serial. 1st part. No. 57467 B.

Interurban.

Denver & Northwestern Interurban Road for Hauling Coal. Illustrates and describes the coal mines and plant, the track and overhead construction, equipment, passenger operation, etc. 3000 w. St Ry Jour—Aug. 1, 1903. No. 57082 D.

Electric Interurban Between Columbus and Zanesville. Illustrated detailed description of a road under construction on a private right of way. Also of the portion of the road which has been in operation more than a year, and its equipment. 5800 w. St. Ry Jour—Aug. 1, 1903. No. 57080 D.

Electric Lines in Northern New York State. An illustrated article dealing with the territory between Albany and Buffalo. 3500 w. R R Gaz—Aug. 21, 1903. No. 57546.

Railway Development in Queens County. An illustrated description of the system of the N. Y. & Queens Co. Ry. which has recently passed under new ownership and of the territory it serves. 4000 w. St Ry Jour—Aug. 22, 1903. No. 57518 D.

The Economy of a Typical American Interurban System. Percival E. Fansler. Report of a comprehensive test of the entire system of the Union Traction Co. of Indiana, to determine the actual working efficiency of the different energy-transforming devices. 3200 w. Elect'n, Lond —Aug. 14, 1903. Serial. 1st part. No. 57484 A.

Italy.

The Milan-Gallarate Electric Railway. P. Letheule. Brief illustrated description of this electric railway line and its operation. 1500 w. Elec Wld & Engr—Aug. 1, 1903. No. 57091.

Leipzig.

Street Railways at Leipzig. A report of concessions, operation, equipment, and management of the electric street railways. 2200 w. U S Cons Repts, No. 1724—Aug. 15, 1903. No. 57168 D.

Light Railways.

Hampshire Electric Light Railways. Illustrated detailed description of an interesting system of electric railways recently completed in England, and the equipment. 1800 w. Tram & Ry Wld—Aug. 6, 1903. No. 57222 B.

Locomotives.

Storage Battery Industrial Locomotives. F. L. Sessions. An illustrated article considering the equipment of a storage battery locomotive. 3700 w. Trans Am Inst of Elec Engrs—July, 1903. No. 57409 D.

London.

The Central London Railway. H. F. Parshall, E. Parry, and W. Casson. An account of various tests made during the first three years' working. Illustrates and describes the equipment and the operation. An underground system worked on the continuous current principle with third rail. 7000 w. Trac & Trans—Aug., 1903. Serial. 1st part. No. 57213 E.

Main-Lines.

Steam vs. Electric Traction for Main Line Railways (Vergleich zwischen Dampf und Elektrischer Traktion auf Vollbahnen). E. Cserháti. A discussion of the applicability of electric traction to main railways, based upon the experience with the Valtellina line in northern Italy. 4000 w. Glasers Annalen—Aug. 1, 1903. No. 57324 D.

Mine Locomotives.

See Mining and Metallurgy, Mining.

Newcastle.

Electric Traction as Applied to the Newcastle Tramways. A. E. L. Rossignol. Read before the Munic. Elec. Assn. Investigates the influence of additional capital expenditure on the cost of current at the tramway power station in Newcastle. 4000 w. Elec Engr, Lond—July 24, 1903. No. 57018 A.

Paris.

Rapid Transit in Paris. Daniel Bellet. Describes the legislation which rules in Paris under which passenger traffic is managed. First of two articles. 7000 w. Trac & Trans—Aug., 1903. Serial. 1st part. No. 57212 E.

The Power Plant for the Metropolitan Street Railway of Paris. Emile Guarini. Illustration of interior of plant, with descriptive notes. 3000 w. Sci Am Sup—Aug. 8, 1903. No. 57170.

Paris Underground.

Details of Construction of the Paris Underground Railway Beneath the Place de l'Opera. Brief illustrated description. 1000 w. Sci Am Sup—Aug. 22, 1903. No. 57299.

Performance.

Predetermination in Railway Work. F. W. Carter. Gives a method of determining performance of the ordinary continuous current railway motor, or motors having similar characteristics. 5500 w. Trans Am Inst of Elec Engrs—July, 1903. No. 57413 D.

Power Stations.

See Electrical Engineering, Generating Stations.

Railway Kinematics.

Plotting of Speed-Time and Speed-Distance Curves from the Acceleration Speed-Curve. L. A. Freudenberger. An extension of the method of Mailloux for plotting curves for the construction of railway schedules from predetermined data. 1200 w. Elec Wld & Engr—Aug. 8, 1903. No. 57158.

Report.

Report on Mr. Young's Return Relating to Permanent Way Construction and Maintenance. Charles A. King. Read at Glasgow conference of the Municipal Tramways Assn. A summary of a report by John Young, containing a great variety of information gathered from a large number of towns. 11000 w. Tram & Ry Wld—Aug. 6, 1903. No. 57223 B.

Single-Phase.

Electric Traction with Single-Phase Motors. Brief account of trials of running an electric car with single-phase currents, made at Milan by Dr. G. Finzi. 1200 w. Elect'n, Lond—Aug. 14, 1903. No. 57483 A.

Sleeping Car.

Plans of the Holland Sleeping Car. Illustrated description of a car intended for service on interurban lines, arranged to serve as a parlor car during the day and a compartment sleeper at night. 800 w. St Ry Jour—Aug. 15, 1903. No. 57254 D.

Steam vs. Electricity.

A Comparison of Steam and Electric Railway Returns. H. D. Emerson. Calls attention to points of interest brought out by the recently issued bulletin of the United States Census Office. 1800 w. St Ry Jour—Aug. 8, 1903. No. 57152 D.

Subway Cars.

Cars for the New York Subway. An illustrated description of the first shipment of cars built for the new subway. 2200 w. St Ry Jour—Aug. 22, 1903. No 57519 D.

Switzerland.

The Albula-Engadin Railway. Emile Rüker. An illustrated description of this line, emphasizing its importance in connection with the development of international traffic. 2000 w. Page's Mag—Aug., 1903. No. 57522 B.

Third Rail.

The Position and Protection of the Third Rail on Electric Railroads. William E. Langdan. Extracts from a paper read before the Engng. Con. of the Inst. of Civ. Engrs., London. Discusses the lack of uniformity in practice, and considers important points. 1500 w. R R Gaz —Aug. 21, 1903. No. 57545.

Trolley Insulators.

Some Recommendations Concerning Electrical and Mechanical Specifications of Trolley Insulators. Samuel Sheldon and John D. Keiley. Gives results of tests made on samples obtained in the open market and recommendations concerning specifications of certain types. Ill. 1800 w. Trans Am Inst of Elec Engrs—July, 1903. No. 57406 D.

Vesuvius.

The Vesuvius Railway (Die Vesuvbahn). H. Morgenthaler. Describing the electrical equipment of the new railway up Mount Vesuvius. 1800 w. Schweizerische Bauzeitung—July 25, 1903. No. 57330 B.

EXPLANATORY NOTE—THE ENGINEERING INDEX.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* Boston.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Jl. of Science. *m.* New Haven, U.S.A.
American Machinist. *w.* New York.
American Shipbuilder. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. d Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *qr.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Sydney.
Autocar. *w.* Coventry, England.
Automobile. *m.* New York.
Automobile Magazine. *m.* New York.
Automotor & Horseless Vehicle Jl. *m.* London.
Beton und Eisen. *qr.* Vienna.
Brick Builder. *m.* Boston.
British Architect. *w.* London.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bulletin American Iron and Steel Asso. *w.* Philadelphia, U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. Soc. Int. d Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Montreal.
Canadian Mining Review. *m.* Ottawa.
Cassier's Magazine. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Electrical Engineer. *w.* London.
Electrical Review. *w.* London.

Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Electrochemical Industry. *m.* Philadelphia.
Electrochemist and Metallurgist. *w.* London.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Cleveland, U. S. A.
Engineering. *w.* London.
Enginering and Mining Journal. *w.* New York.
Enginering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penna. *m.* Pittsburg, U.S.A.
Feilden's Magazine. *m.* London.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland, U. S. A.
Gas Engineers' Mag. *m.* Birmingham.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e. d. Str. Ferr. *w.* Rome.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Ice and Refrigeration. *m.* New York.
Ill. Zeitschr. f. Klein u. Strassenbahnen. *s-m.* Berlin.
Ingeneria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron and Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. Am. Foundrymen's Assoc. *m.* New York.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Journal of Sanitary Institute. *qr.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery *b-m.* Fort Monroe, U.S.A.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U.S.A.
Locomotive. *m.* Hartford, U. S. A.
Locomotive Engineering. *m.* New York.
Machinery. *m.* London.
Machinery. *m.* New York.
Madrid Cientifico. *t-m.* Madrid.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Metallographist. *qr.* Boston.
Metal Worker. *w.* New York.
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* City of Mexico.
Minerva. *w.* Rome.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci Press. *w.* San Francisco.
Mining Reporter. *w.* Denver, U. S. A.
Mitt. aus d Kgl Tech. Versuchsanst. Berlin.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Modern Machinery. *m.* Chicago.
Monatsschr. d Württ. Ver. f. Baukunde. *m.* Stuttgart.
Moniteur Industriel. *w.* Paris.
Mouvement Maritime. *w.* Brussels.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *m.* New York.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Nineteenth Century. *m.* London.
North American Review. *m.* New York.
Oest. Wochenschr. f. d. Oeff Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg- & Hüttenwesen. *w.* Vienna.
Ores and Metals. *w.* Denver, U. S. A.
Pacific Coast Miner. *w.* San Francisco.
Page's Magazine. *m.* London.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Procedings Engineers' Club. *qr.* Philadelphia.
Pro. St. Louis R'Way Club. *m.* St. Louis, U. S. A.
Progressive Age. *s-m.* New York.
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago
Review of Reviews. *m.* London & New York.
Revista d Obras. Pub. *w.* Madrid.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Gen. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Engng. *m.* Ithaca, N. Y.
Stahl und Eisen. *s-m.* Düsseldorf.
Steam Engineering. *m.* Chicago.
Stevens' Institute Indicator. *qr.* Hoboken, U.S.A.
Stone. *m.* New York.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago.
Tijds. v h Kljk. Inst. v Ing. *qr.* Hague.
Traction and Transmission. *m.* London.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining. Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland. Glasgow.
Transport. *w.* London.
Wiener Bauindustrie Zeitung. *w.* Vienna.
World's Work. *m.* New York.
Yacht. *w.* Paris.
Zeitschr. d. Mitteleurop. Motorwagen Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a S.
Zeitschr. f. Electrotechnik. *w.* Vienna.

CURRENT RECORD OF NEW BOOKS

NOTE—*Our readers may order through us any book here mentioned, remitting the publisher's price as given in each notice. Checks, Drafts, and Post Office Orders, home and foreign, should be made payable to* THE ENGINEERING MAGAZINE.

Cams.

The Drafting of Cams. By Louis Rouillion. Size, 8 by 5½ in.; pp. 23; figures, 16. Price (paper), 25 cents. New York: The Derry-Collard Co.

In spite of some inherent objections, cams are widely used in machines, such as harvesters, printing presses, sewing machines, looms and other mechanisms where it is necessary to convert circular into reciprocating motion, and a knowledge of the methods of laying them out is important for the mechanical draftsman. The present pamphlet, which is the second number of a series of practical papers now being issued by The Derry-Collard Co., contains plain and complete directions for designing and drawing cams of various forms for very many purposes. The illustrations are clear, and the whole pamphlet is well and attractively made, and will be useful to the student as well as to the practical designer of machinery.

Cars.

The Car Builders' Dictionary. An Illustrated Vocabulary of Terms Which Designate American Railroad Cars, Their Parts, Attachments, and Details of Construction. 1903 Edition. Compiled for the Master Car Builders' Association by Rodney Hitt, B. M. E., assisted by A M. Waitt, J. S. Lentz and W. P. Appleyard. 12½ by 8½ in.; pp. iv, 525; illustrations, 4,974. Price, $5. New York: The Railroad Gazette.

The original idea of the Car Builders' Dictionary, begun by the Master Car Builders' Association in 1872, was to standardize car-building language, and the successive editions of the work have not only done this, but they have also been a most potent force in standardizing car-building itself. Since the issue of the enlarged edition of 1895, still another important and practical use has been found for the book, it now being employed, wherever there are railroads, as a guide in designing, specifying, and ordering cars. The present edition has been prepared with a view to facilitate its use for such purposes, and shows practically every standard type of freight and passenger cars, and the details of their construction. In general arrangement the lines of the 1895 edition have been closely followed, the book being divided into two general parts, the first 151 pages containing definitions, historical matter and specifications, and the last 374 pages containing the illustrations. The definitions are given in clear and concise language, and, in many cases, are amply descriptive. Wherever possible, references are given to the illustrations in the second section of the book, thus giving a complete alphabetical index to all the engravings as well as defining the terms and parts. In the illustrated pages are shown besides the numerous types of cars and their details, trucks and truck details, car furnishings, electric cars and trucks, together with the electrical machinery placed on them, the standards and recommended practice of the Master Car Builders' Association and car-shop machinery. The aim has been to show present approved practice only, nothing that is experimental and nothing that is going out of use. Particular attention has been paid to steel cars, and the illustrations show the latest types in great variety. Draft gears and brake apparatus have been particularly well illustrated with a large number of examples of the designs most used. Practically every detail of car furnishings is shown in a wide variety of designs. One new subject has been added, that of car-shop machinery. This deals with the machinery most commonly found in car shops and includes illustrations of wood-working machines, forging machines and pneumatic tools, now so largely used in steel car repairs. All these improvements help to make the work more than ever a standard reference book for all who are in any way interested in the rolling equipment of railroads.

Chimneys.

Chimney Design and Theory. A Book for Engineers and Architects. Second Edition, Revised and Enlarged. By William Wallace Christie. Size, 9 by 6 in.; pp. viii, 192; illustrations, 53. Price, $3. New York: D. Van Nostrand Company.

Since the first edition of this book was published, a few years ago, some notable chimneys have been erected and some new methods of construction have been introduced, which are now illustrated and described. Advantage has also been taken of the opportunity afforded by the issue of a second edition to revise the book throughout, some twenty-five pages of text and twelve full-page illustrations having been added. Among the new subjects treated of is radial-brick construction, which is assuming increasing importance, and which is the construction employed for the tallest chimney in the United States, to date, lately erected at Constable Hook, N. J. The chapters of this edition are devoted, respectively, to: Introduction and history; theory of chimney draft; chimney formulæ; chimney tables, wind pressure, air space in grates; foundation materials, brick chimney materials; steel chimneys, theory pertaining to same and examples from existing structures; brick chimneys, with theory and examples; chimney performances, special types, straightening chimneys, flues; house chimneys; lightning protection; general information. Before the publication of this work, there had been very few books on the subject of chimneys, and these were practically out of date, so that the present volume, in which is gathered a great deal of information, hitherto widely scattered, and here treated in the light of the author's large experience, is a most useful one for both engineers and architects.

Earthwork.

Earthwork and Its Cost. By Halbert Powers Gillette, E. M. Size, 7¾ by 5½ in.; pp. x, 244; plates and figures in the text. Price, $2. New York: The Engineering News Publishing Co.

The question of the cost of earthwork is one of the most important which the engineer as well as the contractor is called upon to answer, and too often the answer is only a guess, which may or may not be right, but upon which both the reputation of the engineer and the profit of the contractor depend. In spite, however, of the importance of this subject, the available information on it has been in the form of scattered articles and papers and isolated tables, so that the present volume, which is the first one to treat of earth economics in a comprehensive way, and which contains practically all that is in print on the subject in American technical literature, as well as the substance of the author's own notes founded on his personal experience, is an extremely useful one. The facts and figures quoted are discussed and analyzed, with the aim of deducing rational methods and rules to be used in cost calculations, and the latest practice is described. All the styles of excavating, moving, and dumping earth are considered, from hand labor to the most modern steam shovels and incline conveyors. Besides the treatment of earthwork in general, there are chapters on such special kinds of earthwork as are involved in trenching and pipe laying, post holes, roads, etc., and others on hydraulic excavation, dredging, and rapid field and office survey work. The book is a thoroughly practical one all through, and will do much to put the estimation of the cost of earthwork on a solid basis.

Steam Engine.

A Handbook on the Steam Engine, with Special Reference to Small and Medium-Sized Engines. By Herman Haeder, C. E. Translated from the German by H. H. P. Powles. Third English Edition, Revised. Size, 7½ by 5 in.; pp. viii, 458; figures, 1,085. Price, $3 (10s. 6d.). New York: D. Van Nostrand Company. London: Crosby Lockwood & Son.

Since the first edition of this handbook appeared, the whole work has been carefully revised, and necessary corrections have been made. Tables have been extended and new matter added, particularly in the present English edition, which has been modified so as to more fully meet the requirements of English-speaking engineers, the dimensions being given, in almost every case, uniformly in inches. This volume is a very comprehensive and profusely illustrated handbook for the design of steam engines. Different sections are devoted to: Types of steam engines; details of steam engines; governors; valve gears; condensers, air pumps and feed pumps; examples of Continental engines; particulars of English engines; compound engines; indicators and indicator diagrams; calculations for power and steam consumption; effect of inertia on reciprocating parts; friction brake dynamometer; special reversing gears and other details; and boilers. There are many tables and diagrams, as well as an index, which all help to make the book a handy and useful one for engine makers, mechanical draughtsmen, engineering students and users of steam power.

BOOKS ANNOUNCED.

Practical Farm Drainage. Why, When and How to Tile Drain. By C. G. Elliott. Price, $1. New York. John Wiley & Sons. London: Chapman & Hall, Ltd.

The Alternating Current Transformer. By F. G. Baum. Price, $1.50. New York: McGraw Publishing Co.

Electrical Engineering, An Elementary Text Book. By E. Rosenberg. Translated from the German by W. W. Haldane Gee and Carl Kinzbrunner. Price, $1.50. New York: John Wiley & Sons.

The Art of Pattern-Making. By I. McKim Chase, M. E. Price, $2.50. New York; John Wiley & Sons. London, Chapman & Hall, Ltd.

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"THE WORLD IS ITS FIELD"

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TECHNICAL EDUCATION—WHAT IT SHOULD BE.

By Louis Duncan. With Editorial Commentary.

IN this article I will attempt to do two things: first, to state briefly the condition of technical education in the important commercial countries; and, second, to give my notion of the position of technical education in the United States with its difficulties, its mistakes, and its possibilities.

In the industrial battle being fought between nations, the most important weapon is an intelligent man technically educated. This has been acknowledged in Germany for twenty years; in the United States for fifteen years, and it is now being acknowledged in England.

I think that this is true. Any nation that can put on the market a product cheaper than any other nation will sooner or later have the monopoly of the sale of that product. In national politics, tariffs and subsidies may, for a time, give a temporary advantage to one nation or the other, but in the long run it is a question of cheap production. The cost of production depends on two things—the availability of raw material and the brains of the people who develop that material into finished products.

Technical education has taken individual shapes in Germany, America, and England. In Germany it combines with the painstaking acquirement of knowledge, typical of German education, an idea of research; in America it is the old-fashioned general collegiate education modified by paying special attention to technical subjects, with a veneering of manual training; in England to-day it is chaotic, but with a tendency to keep technical education on a trade basis.

As far as facilities go, Germany depends upon State aid, which has been liberally supplied; America, to a large extent upon personal contributions; while England is in the unfortunate position of having little State aid and no large benefactions.

The aim of technical education is to apply scientific discoveries to practical work. When any new discovery is made in science, there are two attitudes to be considered: the first is, how can I develop this discovery; the second is, how can I apply it. Germany, without neglecting the second attitude, has added to its technical instruction the first attitude—that is, the Germans combine research with application. In America, it is only lately that technical education has concerned itself with research work.

Any one who has been through a technical course and afterwards done practical engineering work, will acknowledge this fact: that when a new problem comes up, it is attacked not on the basis of the elaborate detailed instruction which he has received, but from the point of view of a few general principles that should have been instilled into him; and when such a problem presents itself to him, he feels sorry that the details had not been omitted, and the general principles emphasized.

In most of the technical courses given in the average college to-day, mathematics is taught up to and through differential equations, and yet it is so taught that not one in a thousand ever applies differential equations and calculus to practical problems, but works them out with the multiplication table and a slide rule. In mechanics, for instance, instead of being given the fundamental equations and being taught to apply these equations to simple cases, we are given the special solutions of intricate problems, the text books preferring the most elegant solutions, and not laying stress on the direct application of the fundamental equations, irrespective of whether it is difficult or long or ungraceful. And I wish to lay special emphasis upon what I have said about mathematics. As it is given to-day in America, outside of the possible value of the mental training, it has little utility in the life work of an engineer. For example, the value of a graceful solution of the problem of the fall of a pendulum, given to a nineteen-year-old youngster, is problematic. He would enjoy a Sherlock Holmes' story more and it would do him more good. We should do this with our mathematics in technical courses: either drop the calculus and differential equations entirely, or so teach them that the student can apply them in his future engineering work.

The fault of our technical education in America is that it is too technical and that there is too much instruction. It seems to be the idea that the longer contact the student has with his lecturers or with his text books the more information he will obtain. It does not seem to be considered that information, as such, is not of great importance. It can be obtained easily and cheaply when occasion arises; and the end and aim of a technical education should be not to obtain information, but to apply it. We should not attempt to make mental storehouses of men, but mental factories.

Another thing is this: that to a large extent, the ability of a man to work out any specific problem depends on his being able to make a mental plot of the problem, and to keep it constantly before him. For instance, a railroad proposition for a city, presented to an engineer, involves an infinity of different considerations—the population of the different districts of the city, the character of the population, the growth, the franchises under which the road is to be built, the political complexion of the city government, the question as to whether the capitalists who are building the road intend to operate it or to sell it—these and a hundred other considerations must form part of the plan adopted. To take all these into account, to keep them constantly before one until the scheme works itself out, requires an imagination that has been developed and not suppressed. A large part of the work is done outside of any office—in street-cars, at dinner—unconsciously to a certain extent.

I wish specially to emphasize this point. The amount of work done at desk or before a drawing-board is a very small proportion of the total work needed for a large engineering proposition. The successful engineers are those who can see the problem as plainly while they are walking on the street as they can see it on a blue-print.

I saw some time ago in one of the daily papers a discussion of the requisities for success in life, and some one, I think it was Mr. Cleveland, summed things up by giving as the three requisites, character, persistence, and intellect. The fact that intellect was placed third on the list surprised many people, but this is true. Suppose a brilliant man does a certain piece of work in a certain time; another man does the same work in twice the time; the first is usually considered as having about twice the intellect of the second, and by the ordinary definition of intellect, which emphasizes the time element, this is true. But any one with average brains can work out any reasonable proposition, provided he works at it long enough, and this ability, of which I have spoken—the ability to keep a proposition constantly in front of one, the quality of imagination—constitutes the difference between the finally effective man and the so-called brilliant thinker. Brilliancy is merely the time-factor of application. Newton said that his success was not due to the fact that he was smarter than other people, but to the fact that he thought more than other people.

The curriculum of our technical courses has for its object the training of students to obtain engineering results under ideal conditions. Electrical engineering, for example, would have been cursed by Thomson's law for the most economical section of electrical conductors, provided any competent engineer ever used this law, which he does not. Still, this law is an important part of electrical engineering instruction. The fact of the case is this: problems cannot be worked out as engineering abstractions, but must take into account financial conditions, political questions, social questions, and all the complex considerations that make up real life instead of ideal life.

In looking over the list of successful engineers (I am speaking now of electrical engineers, because I know very little of any other branch), we do not find that we can point to any one institution as having produced more successful engineers than any other in such a way as to make the difference marked. In fact, I am afraid that our largest and best equipped institutions do not show as fair a percentage of leading engineers as some of the smaller, poorly equipped colleges. I think this is due to two things; the first is that the larger institutions have presented courses including more instruction than can be given in smaller institutions, and I believe that at least half of this has done harm rather than good. The other cause is obvious, i. e., that in the smaller institutions the students are more directly in contact with the instructors, and that they do not have the facilities for work that the more ambitious colleges have; that is, when an experiment is to be tried, the ingenuity of the student, and not his patience, is exercised.

There is another matter which I wish to emphasize. The fundamental ideas of electrical engineering are given in the first two years of our typical American technical course, and afterwards the applications are given without a continual reference to the fundamental principles. In the applications to practical work, each specific case is taken up as a thing apart; there is very little atmosphere of theory.

But outside of the technical training given in any school, there is this thing on which the monetary value, and the real value, of a graduate depends—he must be loyal to his employer. As one who has worked for other people and who has employed other people, I can state this: the value of a man on whom one can absolutely depend is twice as great as the value of one with the same ability who has not a feeling of loyalty. This does not necessitate any surrendering of self-respect or of independence. It simply means sympathy with one's work and with one's employer.

In the American technical course, the question of manual training has been given different consideration at different colleges. It was pointed out by Professor Sheldon last year that Cornell gave ten times as many hours to manual training as the Institute of Technology. One wonders whether Cornell graduates lose nine-tenths of this time, or the Technology graduates are handicapped one to ten. Frankly, I do not believe that this is a matter of much importance. Few graduates of the technical colleges are called upon to exercise manual-training arts, and the only value is an educational one; although unquestionably the ability to use a lathe or wield a sledge may assist one in the emergencies that arise in the course of engineering life.

To sum up: Germany is supplying a magnificent basis of engineering research, but is weak in the application of this research. In England there is a tremendous gap between Thomson's theory of electrons and instruction in wood-turning. Here in America, we have crowded into twenty years of commercial development the results of two centuries of the world's research, but we are now nearing the end of the researches which we have appropriated, and we must soon either lay fresh foundations or stop building.

DR. DUNCAN'S acquaintance with the field of technical education is intimate. As pupil and later as teacher in both undergraduate and post-graduate schools, and at the same time as an engineer constantly active in creative and constructive work of high importance, he has had unrivalled opportunity to study the relation of the school to the worker, and the influence of educational ideals and systems upon the practical cultivation of the talent they are intended to foster. He has watched the technician in the making, in what is perhaps the most characteristic field of the times—that of electrical engineering in the United States. It seems to us, therefore, that it will be of interest to place in comparison beside his views those of some of the foremost European thinkers on the same subject.

There is no dissension as to the ends sought. As Dr. Duncan epigrammatically puts it, the aim is to make of the students not mental storehouses, but mental factories. Nor is there any uncertainty as to the importance of attaining this end if industrial success—which nowadays includes all success—is to be secured to the nation. As Sir Norman Lockyer says in the excellent address reviewed in full in our Review pages in this issue, "we are suffering because trade no longer follows the flag as in the old days, but because trade follows the brains, and our manufacturers are too apt to be careless in securing them." As he puts it elsewhere, confirming strikingly the position constantly urged by us editorially in this Magazine,

> "It is a question of an important change of front. It is a question of finding a new basis of stability for the Empire in face of new conditions. It is, moreover, a struggle in which science and brains take the place of swords and sinews, on which depended the result of those conflicts which, up to the present, have determined the history and fate of nations. The school, the university, the laboratory and the workshop are the battlefields of this new warfare.

Mr. Joseph Chamberlain put the statement quite as unequivocally in a quotation taken from the *Times* some two years ago:

> "I would remind you that all history shows that progress—national progress of every kind—depends upon certain individuals rather than upon the mass. Whether you take religion, or literature, or political government, or art, or commerce, the new ideas, the great steps, have been made by individuals of superior quality and genius who have, as it were, dragged the mass of the nation up one step to a higher level. So it must be in regard to material progress. The position of the nation to-day is due to the efforts of men like Watt and Arkwright, or, in our own time, to the Armstrongs, the Whitworths, the Kelvins, and the Siemenses. These are the men who, by their discoveries, by their remarkable genius, have produced the ideas upon which others have acted and which have permeated the whole mass of the nation and affected the whole of its proceedings. Therefore what we have to do, and this is our special task and object, is to produce more of these great men."

And collateral with this strong assent to the proposition that industrial science is the very groundwork of national prosperity is the strong complaint that methods of teaching are not well adapted to the end for which they are intended. Dr. Duncan's criticism is amplified and urged by Professor Charles Vernon Boys, in an address before the British Association:

> "Beyond having time to acquire a few elementary algebraical rules the boy is never introduced to algebra proper; he has no idea of algebraical reasoning; his trigonometry often does not exist, and the very sound or suggestion of coördinate geometry or of the differential calculus, which might be well within his reach, produces a shiver of dismay. . . . If Euclid must be retained let it be translated into English, the English that any parent would use in explaining the ideas to his son; let it be illustrated by constant reference to real things so as to appeal to the boy who does not revel in the abstract. Let the ideas

> and the terms first be presented in the form of experiments and of measurements with instruments; let the schoolmaster dare to throw over the intolerable conservatism which prevents our doing anything ten times as well lest some item should prove to be a trifle worse. . . . Is it any use to repeat the long-standing complaint of the way in which the schoolmaster insists upon overdoing his Latin and Greek under the belief that they are at least essential to intellectual development if, indeed, they do not supply the only stimulus? . . . The time given to classics is exorbitant; more must be reserved for those pursuits which draw out the habit of independent thought, creation, and originality."
>
> "I remember in my early days, in the surroundings of a classical atmosphere, the general feeling of contempt for the manufacturer, the intellectually inferior creature who only made money. . . . I am not sure that some such feeling does not still exist among those whose horizon is limited to the Latin and Greek that they have learned—or should I say limited *by* instead of *to?* This recollection came back to me when not long ago I was visiting one of the best organised and most skilfully conducted works in the country—I mean Willans and Robinson—when I remembered that another great manufactory, conducted on American lines, was near by, and when across the road I saw the walls of one of our most famous English schools. I pictured the old contrast: on the one hand the conviction impressed upon me when a boy that there is something intellectually superior in the struggle with a paragraph of Xenophon or a page of Homer, while manufacture is merely mechanical, sordid and base, with what I believe to be the reality on the other. I wondered in what spirit the erection of these works was viewed at the school and to what extent the high intellectual attainment there so essential and so evident is properly appreciated."

Surely it is an eminently proper demand that the training which is to fit its subjects for the highest service in drawing out the nation's material resources, should itself set the example of drawing out the pupil's mental resources—should provide him with the tools most efficient for the work in which he is to be engaged.

The possible relation between technical training and higher education in Germany may be gathered from the noteworthy address delivered before the Society of German Engineers by Professor Ostwald. Concluding an argument for the closer union between the engineer and the chemist he said:

> "There are few among those who understand the true condition of educational matters in Germany who do not deplore the mistaken view which is taken by the universities of the movement toward higher technical education during the past fifty years. How then may this unfortunate division between the two greatest elements in the training of the nation be avoided? It is as impossible to conceive of the entire absorption of the technical school by the university as it is to imagine the reverse. Nothing then remains but for each to work out its own de-

> velopment with a view to a future co-operation. Already in recent years we have observed a tendency in this direction in the development of independent scientific investigation in the technical schools, this movement being altogether in harmony with the highest aims of the university, and the import of this tendency cannot be too highly emphasised. There is, however, yet lacking a conscious co-operation in this work between the two elements. It cannot be denied that the development of the technical high schools of Germany along the lines of higher learning is not regarded with favor by the universities; while, on the other hand, the work of the universities in scientific research is too often viewed by the technical schools in the light of unauthorized and reprehensible competition. Is it too much to hope that with a better understanding of the limits of each by the other, such narrow views may disappear? I myself believe that such a result may be attained in this as in the union between two branches of scientific work which were formerly widely separated. At least some slight beginning has already been made in this direction, and the auspicious union in the work of the various laboratories of Germany, of which this gathering in Munich is such a notable example, may ultimately be extended to include in similar manner both university and technical high school and impart to each a twofold energy and a twofold influence."

The growth of technical training in Germany has followed naturally upon the general progress which has been made in the last century in the application of science to industry and to the affairs of daily life. In this respect the present position of scientific education in Germany may well be considered as an effect as well as a cause of national development. This point is well brought out in an address by Herr Gustav Schmoller, recently delivered at Munich upon the relation of technical development to national and personal progress, in which he shows clearly the great extent to which the introduction of scientific methods and appliances has promoted personal comfort and national prosperity. Tracing the growth of Germany from its period of great depression at the time of the Seven Year's War to the middle of the nineteenth century, in comparison with the tremendous progress which has been made since that time, he shows how the work which the older education and the older methods of training could not accomplish has been effected by the engineer, by the scientist, by the machine builder, and by the man of applied technology.

The present period, pre-eminently the period of the entrance of applied science into the affairs of daily life, has given to the people of the nation more and better homes, better food, better health, better returns for labor of all kinds. If methods are to be judged by their results, the technologist may join issue with the schoolman without fear as to the verdict.

THE EDITORS.

THE FIXING OF PIECE-WORK RATES.

By Hugo Diemer.

Much of the discussion of shop systems and works management has started with the assumption that rates were already fixed, and has dealt with details of administration only. As a matter of fact, the determining of correct rates is the fundamental starting point of any system. Mr. Diemer's article is based on concrete experience. Discussion of either details or the general principles involved will be cordially welcomed.—The Editors.

THE best field for the use of what is known as the "straight piece-work" system is in an establishment engaged in a strictly manufacturing business. The term "manufacturing" is here employed to convey the idea of the production of the same identical product in large quantity. A more complete definition would state also that a company engaged in a purely manufacturing business is able to anticipate quite accurately its annual output as regards range of sizes and types and quantities of each to be manufactured. Thus companies producing such articles as bicycles, sewing machines, cameras, or agricultural machines, may be put into the class of purely manufacturing establishments, as in contradistinction to works dependent to a large extent upon the receipt of orders whose range of variety and sizes of product may be such as to change the prospective output completely in the course of a few months. To the latter class would belong most establishments manufacturing steam and gas engines, dynamos and motors, and special machinery in general.

The correct basis for piece-work rates is the least possible time required to do the operations involved and turn out a product that will pass the inspecting department as satisfactory. This time is made up of two parts:—1, that spent in preparatory and supplementary work such as jigging, chucking, taking out, gauging, etc.; 2, that spent in active work while the machine is in operation.

The time that should be spent in active machine work is a matter that can easily be determined. In machine-tool work where one workman operates a single spindle it will be limited only by the highest speed that the tools and machinery will stand. In multiple-spindle work there is no advantage in the cutting operation being done more rapidly than the shortest time that will permit of continuous active work on the part of both operator and machine.

It is evident that in a purely manufacturing establishment the variable factors involved in the handling steps can be determined with a far greater amount of certainty than in jobbing work, since in the former case the operation is being done on the same piece in the same manner day after day. A jobbing shop may with advantage go so far as to prepare a routing tag for every piece and specify the maximum feed and speed attainable in machining, and also the minimum time that it is estimated should be taken in the chucking, handling, etc. But in the jobbing shop the average workman is not expected to accomplish the work in the minimum time thus set, since he does not repeat the work often enough to get into a fast gait. Hence the premium wage system with its fixed day rate is gaining in favor in jobbing shops. In fact, there are instances of the premium system being combined with a bonus of a fixed daily amount for the accomplishment of all tasks undertaken and completed in a specified time. In strictly manufacturing processes, however, the workman need not be the good all-around machinist that is required for jobbing work. In fixing the time it should take a man who is working continuously on the same operation to accomplish his work, it is only fair to expect him to turn out the work far more rapidly than would be expected in a jobbing shop. Being less intelligent as a rule and less ambitious than the all-around machinist of the jobbing shop, the workman in the manufacturing establishment cannot be depended upon to turn out voluntarily enough product to earn a fixed day rate. Nor is he apt to be sufficiently ambitious to respond to any inducement offered by premiums or bonuses. It is absolutely necessary to set the piece rate low enough to insure the workingman's exerting himself in order to earn what he considers his day's compensation. Most modern machine-shop work is so much relieved of heavy labor that lively movement on the part of the worker is no hardship. Where the work is heavy, time allowance will have to be made for pauses and intervals of rest.

The hackneyed injunction about the necessity of rigidly adhering to a piece rate once fixed falls flat when applied to rate fixing intelligently undertaken. Piece rates can be made correct at the outset if the work of rate fixing is correctly undertaken, and based upon scientific research rather than upon the guessing which is often misnamed "judging."

Any successful piece-work system will always provide a guarantee to the workman that he will be insured against loss from causes beyond his control. This is easily accomplished by the transferring of the worker to a day rate when circumstances warrant it. Such transfer should always be recorded by a transfer ticket, stating the date and time of day the transfer is made, together with the reason for the transfer to day rate. These tickets are collected by the time keepers and turned over by them to the pay-roll department, where they should not only be kept on file, but should be noted and compared by some person of authority, so as to avoid too free an indulgence in the transfer to day rate.

There is a growing sentiment prevailing today among progressive machine shops, in favor of a general careful investigation and revision of piece rates. The tests connected with the widespread exploitation of air-hardening tool steels have in many cases revealed the existence of inaccuracies and discrepancies in existing piece rates, that have led to a serious consideration of the adoption of better methods of fixing piece rates than have been formerly employed. The usual method has been for the foremen to decide what the rates should be. In many cases it is quite customary for a foreman to have his time keeper jot down the numbers of pieces on which work is being done and on which no piece rates have been set. These memoranda are allowed to accumulate until a few hours before it is necessary to advise the pay-roll department of new piece rates, with the result that the work of rate fixing is done very hastily. The foundations on which foremen are generally acustomed to base piece rates are previous prices paid for similar pieces, and what the foreman chooses to call his "judgment." Notes based on actual observations of the work are seldom taken, and very rarely are observations recorded on the distinct elements or steps in operations. The general tendencies and attitudes of one foreman will be very different from those of another. The natural result is that similar work is differently compensated in different departments of a factory where the foremen are wholly responsible for piece-work rates.

I do not believe it at all wise to attempt to take away from foremen certain rights with regard to the establishment of piece rates. On the one hand, the foreman has no right to consider himself the supreme authority in his department. The owners of a business certainly have rights in the important question of wages. On the other hand, the foreman feels that he is responsible for the output of his department, and it is not only fair but absolutely essential that his concurrence be secured at every step taken. The ability to secure such concurrence and the good will of foremen in general, is an indispensable qualification of the man in charge of a rate-fixing bureau.

In taking field notes which are to be a basis for piece rates certain simple tools and instruments are indispensable, namely surface speed indicator, revolution counter, calipers, scales, and, unfortunately the stop watch. Various expedients have been tried and suggested for the concealing of the stop watch, but the writer has yet to learn of any such ruse which will not be discovered and word of it spread all over a shop in a very limited time.

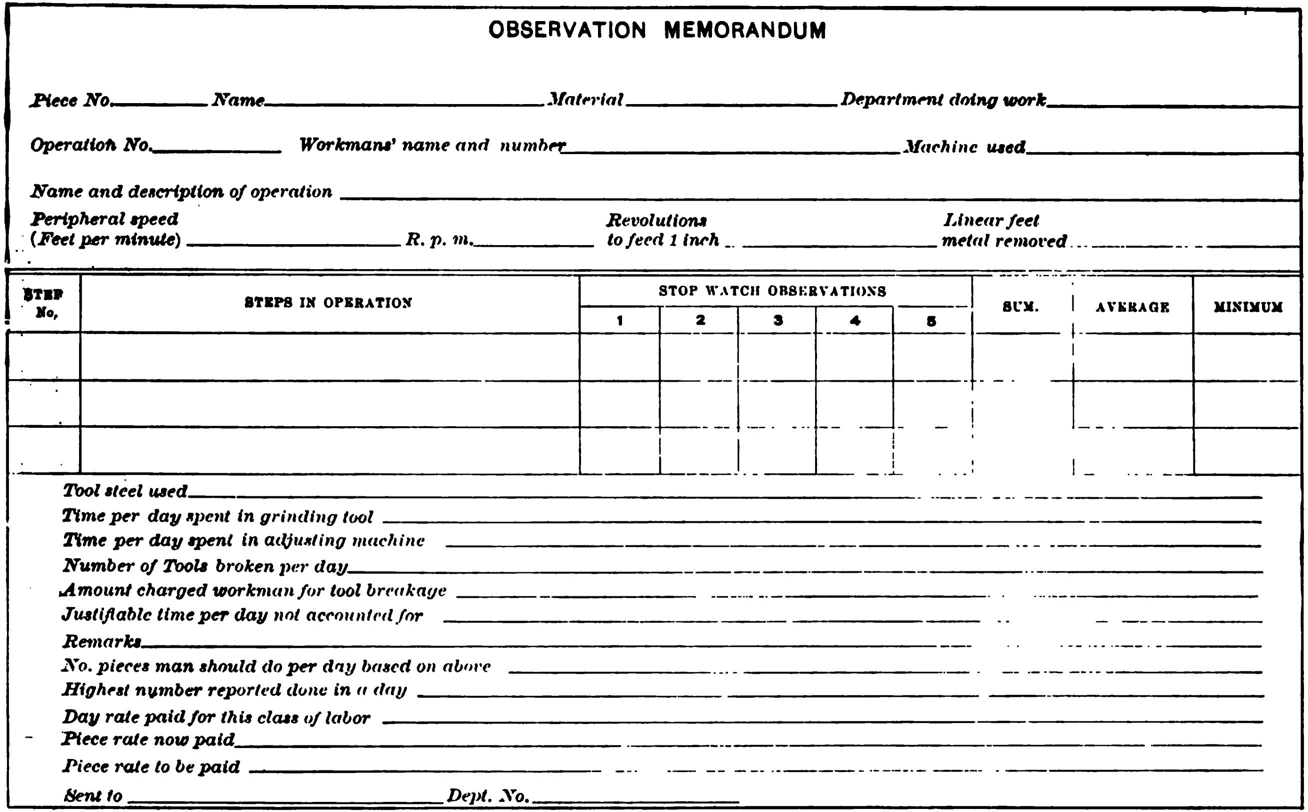
A careful investigation and accurate determination of speeds of all machine tools is a prerequisite to the institution of a rate-fixing bureau. This investigation will consist in recording the speeds of line shafts, countershafts, and all spindles, together with all steps of cone pulleys and all variations in speed to be obtained by change gears or any other devices. A card record should be established, indexed by departments, and cross indexed to show all like tools, the individual cards bearing numbers coincident with the serial permanent inventory number attached to each machine tool. On these cards will be recorded the make, style, and age of the machine, together with the speed data above referred to. The proper pulley or gear combination for various diameters of stock at various cutting speeds can also be tabulated on these record cards. The work of calculation involved in such tabulation is greatly facilitated by the use of Mr. C. G. Barth's circular slide rules especially designed for this purpose.

The preparation of the speed record will take considerable time, probably some months. During this time the workmen will have become accustomed to the unconcealed use of the stop watch by one or more observers. The extreme delicacy with which the stop-watch question is here treated may be surprising to some readers. However, in centers of constant labor agitations, every possible agency that may be the spark to ignite the strike fire is necessarily dealt with cautiously.

After several months use of the stop watch in the collection of data necessary for the speed record, it is not likely that any trouble will be created by the use of the watch in recording the time required in the various handling operations.

The preliminary work in connection with the preparation of the speed and machine record may advantageously be accompanied by an investigation of the merits of various makes of tool steel as adapted to the special work at hand.

After the completion of the preliminary work, the real work of rate fixing may begin by taking observations and establishing rates on all new pieces, with the foremen's co-operation, at the same time



OBSERVATION MEMORANDUM

*Piece No.*________ *Name*____________________ *Material*________________ *Department doing work*____________

*Operation No.*__________ *Workmans' name and number*____________________ *Machine used*____________

Name and description of operation ____

Peripheral speed (Feet per minute) ______________ *R. p. m.*________ *Revolutions to feed 1 inch* ______________ *Linear feet metal removed* ____________

STEP No,	STEPS IN OPERATION	STOP WATCH OBSERVATIONS					SUM.	AVERAGE	MINIMUM
		1	2	3	4	5			

*Tool steel used*____

Time per day spent in grinding tool ________________________________

Time per day spent in adjusting machine ____________________________

*Number of Tools broken per day*______________________________

Amount charged workman for tool breakage ____________________________

Justifiable time per day not accounted for __________________________

*Remarks*____

No. pieces man should do per day based on above ______________________

Highest number reported done in a day ______________________________

Day rate paid for this class of labor ______________________________

*Piece rate now paid*________________________________

Piece rate to be paid ________________________________

Sent to ____________________ *Dept. No.*______________

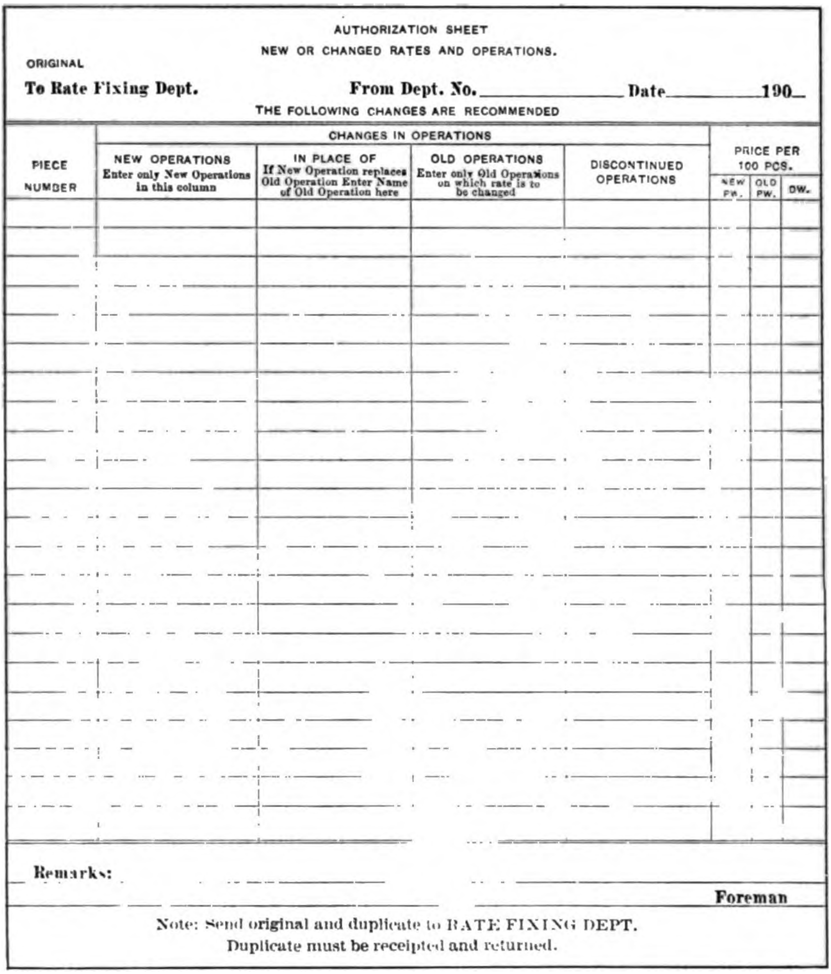
FIG. I. OBSERVATION MEMORANDUM.

The sheet is 11 inches wide by 8 inches high, ruled and printed in black on white paper.

beginning observations on some single machine, taking piece by piece and operation by operation. If conditions are such that a change in the rate appears desirable and no such immediate change is advisable, the record is valuable to be made use of at the first opportune moment.

A form used by me for an observation memorandum is shown in Figure 1. In many cases not all of the data called for will be obtainable or necessary. Individual tastes will determine the exact size and shape of such a form. A book has always the disadvantage that the original data sheets cannot be easily classified and filed away, as is the case with a loose-leaf system. Referring to the form, the items calling for time spent in grinding tools, time spent in adjusting machine, and justifiable time per day not accounted for, will constitute difficult observation data. They would best be estimated by a whole day's observation on some typical piece of work which could be used as a basis to cover a group of similar jobs. In an establishment where special tool-grinding departments are maintained, the item covering time spent in grinding tools will, of course, drop out. There are few factories in which it would not be advantageous to maintain tool-grinding and storage departments in various parts of the plant. The claim has been made that each man likes his tool ground in his own way and becomes attached to some particular tool which he might not get back from a general grinding room. These points are offset by the fact that some men are much harder on tools than others, and that a skilled grinder will be able often with a few words to tell them where their trouble lies. One of the best arranged tool-storage and grinding rooms I have seen is separated from the general shop by an open heavy wire-net fence, through which the open metal racks, with numbered spaces containing the tools, are plainly visible. The open-rack method of storing tools saves a great deal of time over any storage method employing drawers or boxes.

In securing the observational data, the personality of the observers is a matter of great importance. A carefully selected man can go into the works and take all the observations necessary and at the same time have the good will and friendship of men and foremen. Another man doing exactly the same routine work might easily and unconsciously to himself be considered offensive by the shop hands. The essential qualifications for such observers are, first, a sound and discriminating judgment based on an inherent sense of justice; second, ability to take and appreciate the value of precise observations, such as is developed in laboratory training; third, an unassumed spirit of democ-



AUTHORIZATION SHEET

NEW OR CHANGED RATES AND OPERATIONS.

ORIGINAL

To Rate Fixing Dept. From Dept. No.________ Date________190_

THE FOLLOWING CHANGES ARE RECOMMENDED

PIECE NUMBER	CHANGES IN OPERATIONS				PRICE PER 100 PCS.		
	NEW OPERATIONS Enter only New Operations in this column	IN PLACE OF If New Operation replaces Old Operation Enter Name of Old Operation here	OLD OPERATIONS Enter only Old Operations on which rate is to be changed	DISCONTINUED OPERATIONS	NEW PW.	OLD PW.	DW.

Remarks:

Foreman

Note: Send original and duplicate to RATE FIXING DEPT.
Duplicate must be receipted and returned.

FIG. 2. SHEET FOR CHANGED RATES AND OPERATIONS.

The sheet is 7¼ inches wide and 11 inches high, white paper. A duplicate, pale buff in color, is attached directly behind the original by a gummed upper edge.

racy and modesty; fourth, ability to stand one's ground without creating antagonism. In short, character and tact will be the chief requisites.

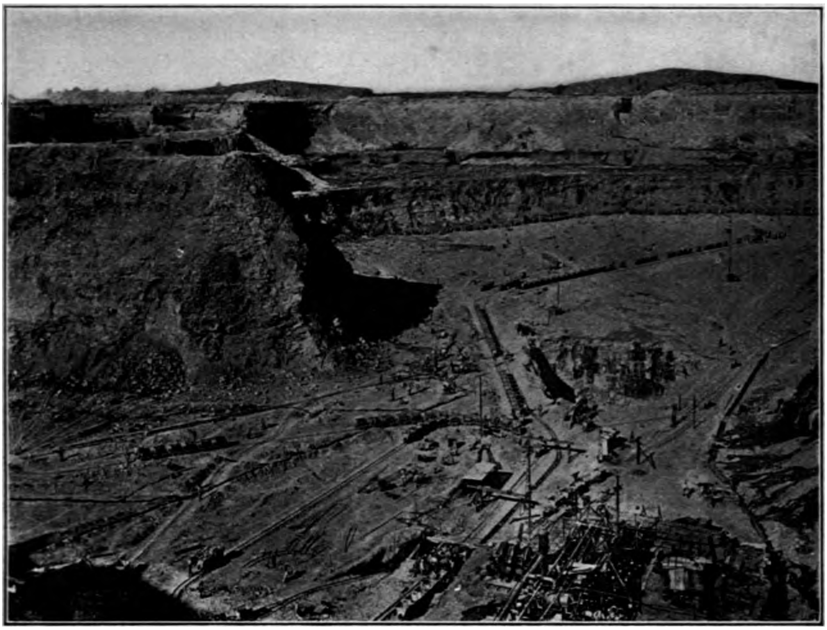
In addition to taking observational data, a rate-fixing department should prepare such statistical data and charts as will be valuable in predetermining and checking piece rates. After taking such "field notes" as may be desirable, the observer goes to the department office and "works up" his notes; i. e., he determines on what he considers a fair piece rate for each operation observed, and investigates also the statistics on file, using the statistical information as secondary and not primary reference. After he has thoroughly worked up the results of his study, the observer visits the foremen of the departments in which he took observations with a view to co-operating with the foremen in filling out an authorization sheet covering new or changed rates. The foreman's interest and co-operation is always essential. Hence the authorization sheet should be signed by the foreman, and its arrival in the office of the rate-fixing department should be evidence that the rates have been sanctioned by both foreman and observer. A form suggested for this authorization sheet is shown in Figure 2.

A card index of all piece rates is kept up in the department office by postings from the observation and authorization sheets. The general form and arrangement of this card index will depend upon the nature of the business and product.

The regular routine of the work of the department would consist of a methodical review of all existing piece rates, accompanied by a continuous system of notices of all new work undertaken. Notices of any new pieces on which work is begun and on which new piece rates are desired, are sent by the time keepers in various departments to the rate-fixing department, and an observer from the rate-fixing department responds at once to this call.

A regular routine system as above laid out will be far preferable to an occasional and more or less disconnected series of observations used merely as a stimulus to greater accuracy on the part of foremen. There is danger of the foremen regarding the work as less authoritative and considering that it is being done in a half-hearted way, unless it has the impetus and swing of a regular routine system.

The number of men to be employed in instituting a work of this kind will depend wholly upon the number of pieces to be investigated, and their similarity. The qualifications of the men are such that they are likely to be as high-salaried as the best foremen. While the employment of additional so-called non-productive labor is not in line with any policy of retrenchment, it is evident that present conditions in many large factories are such that the right kind of men working on piece rates could save their salaries many times in a year.



DE BEERS PREMIER MINE, WESSELTON.

THE MECHANICAL EQUIPMENT OF THE KIMBERLEY DIAMOND MINES.

By *Chas. V. Allen.*

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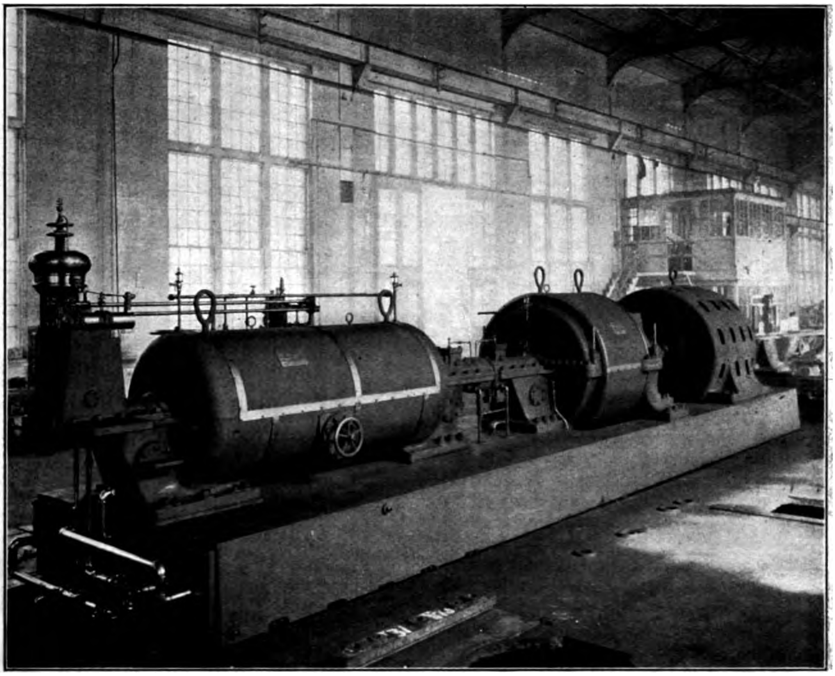
A PRECEDING article sketched briefly the history of diamond mining in Africa, and more particularly the remarkable process of consolidation by which the many petty claims were brought under a single management and an efficient and economical method of mining. The last year has seen many changes in the method of operating the mines, many of these being made necessary by the increased depth to which the mines are now being worked. The introduction of electricity as a motive power is the latest development, this method of driving being installed not only at the mines but throughout the entire kindred holdings of the organization, one of the more important being the large plant for the manufacture of explosives located at False Bay near Cape Town, and known as the De Beers Explosive Works.



ONE OF THE WESTINGHOUSE-PARSONS 1,000-KILOWATT TURBO-GENERATORS.

The De Beers Company have erected a large new power house in Kimberley for supplying electricity to the mines thereabouts, in which they are installing two of the latest type of Westinghouse-Parsons steam turbines. This power house is fitted with eight Babcock & Wilcox water-tube boilers with a heating surface of about 3,500 square feet for each boiler. Additional space for four others has been provided for future extensions. Each of these boilers is fitted with superheater. Mechanical stokers of the chain-feed type are used. All coal is handled by conveyors, and mechanical draught fans are used to create induced draught. Economizers take up the heat of the gases after leaving the boiler furnaces, and surface condensers are used. Circulating and air pumps are also electrically driven by motors. The day-load distributed horse power of the plant is 3,385 and the night-load 2,350 horse power.

In the adoption of the latest development of electrical generating apparatus, the steam-turbine sets, the De Beers Company by introducing this apparatus in this remote country indicate full confidence in this type of apparatus which is now being so generally sought. The particular units which comprise the De Beers installation consist of steam-driven turbines directly coupled to and mounted on the same base with turbo-generators rated at 1,000 kilowatts capacity, the winding of these generators being three-phase, 5,000 volts. The entire unit makes a speed of 1,500 revolutions, and being four-pole machines they give a frequency of 6,000 alternations. The generators are of the rotary-field type, and when operating at 50 per cent. overload will not exceed 38° C. rise.

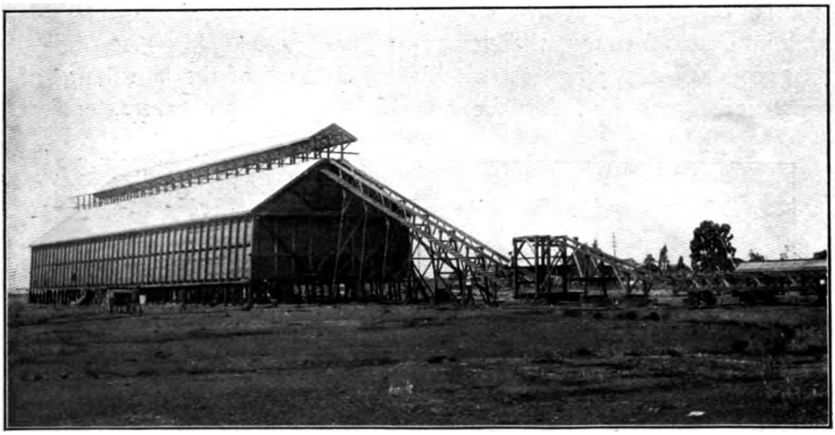
The steam turbines have an equivalent overload capacity, so that the actual capacity of the central power house as a whole is 3,000 kilowatts, or about 4,000 horse power. This power house is arranged for the addition of another unit when more power is required.

For exciting the fields of these generators there are installed in this station two motor-generator exciter sets, each consisting of a 50-horse-power 220-volt alternating-current motor mounted on a common base with and direct-connected by means of a flexible coupling to a 37.5 kilowatt 110-volt direct-current generator, the outfit making 720 revolutions. The current supplying these exciter sets comes from a bank of three 400-kilowatt oil-insulated self-cooling Westinghouse transformers, the primary of the same being 5,000 volts, the secondary 220 volts. A suitable switchboard of the latest type of construction provides for the control of these generators, exciter

DRILLING UNDERGROUND WITH COMPRESSED AIR IN THE KIMBERLEY MINES.

sets, transformers, and also the various outgoing 5,000-volt three-phase feeder circuits, as well as the local power-house, auxiliary-motor, and lighting circuits.

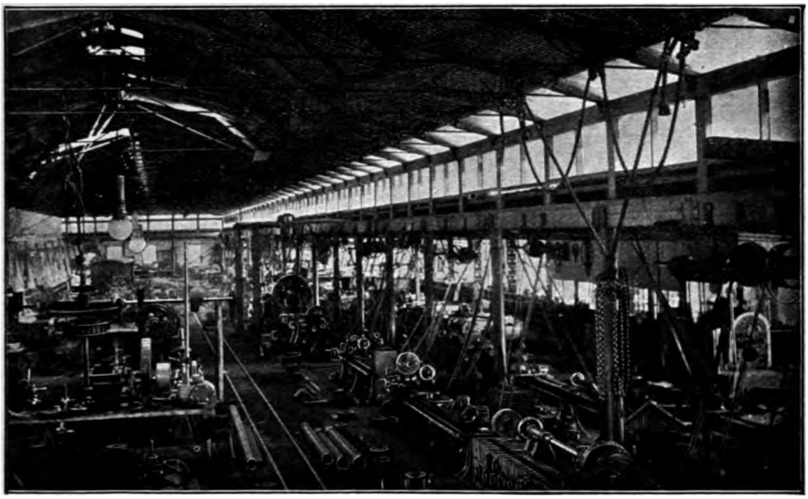
The various motors used in the power station itself, such as those employed for driving the ash and coal conveyors, air pumps, circulating pumps, crane, coal breakers, etc., are operated from 220-volt direct-current and 220-volt three-phase alternating-current sources of power. The alternating motors, which are of Westinghouse make, and of varying capacity, drive Robins coal and ash conveyors, Blake and Knowles pumps, Fraser & Chalmers compressors, etc. The conveying plant is driven by a 10-horse-power alternating-current motor and comprises a 16-inch belt about 175 feet long carrying coal which has previously been passed through two coal crushers driven by a 20-horse-power alternating-current motor. The coal carried by these conveyors is automatically tipped into hoppers above the boilers, this being so done that all the hoppers are kept filled up to a uniform depth.



4,000-TON COAL BUNKER FED BY 24-INCH ROBINS CONVEYOR, WITH TRIPPER. DE BEERS MINE.

In connection with this large mining plant there are fully equipped and very modern machine shops in which small motors have been introduced for driving many of the larger individual tools. In this way a large amount of countershafting and belting has been done away with, resulting already in a great saving in power and in maintenance. As a result of this still further changes in this line are to be made shortly.

For each of the larger tools a separate motor is provided in most cases. The smaller tools, such as small lathes, shapers, screw machines, etc., are divided into groups of three or four tools and each group is driven by a separate motor. Power is metered out to each shop department, so that it is possible to apportion and determine accurately the power consumed in the various departments of the shop. There will be in all about thirty motors installed, ranging from 2 to 30-horse-power capacity. For these workshops has been provided a synchronous motor of 120-horse-power capacity, three-phase, 220 volts, 600 revolutions, with its exciter, which motor drives a 75-kilowatt, 220-volts direct-current generator, both being coupled together. A suitable switchboard is provided for control of this outfit.



DE BEERS MACHINE SHOPS.

Besides the power operating the constant-speed alternating-current motors and the mining locomotives, there are also in use two small electric hoists requiring motors of about 3 horse power each, and eight larger hoists requiring motors of 75 horse power each. The larger hoists are used intermittently 24 hours per day, the work being continuous for periods of four hours, they being idle only long enough to reverse. The motors operating them are 220-volt induction type. The cages are balanced, the rope being unbalanced; the balance load consists of two cages of about 2,500 pounds each, there being two mine trucks, one in each cage, and the weight of each being about 700 pounds. An unbalanced load of about 1,800 pounds is raised 700 feet through a vertical shaft at the rate of 500 feet per minute after reaching full speed. A wire rope 2¾ inches in circumference is used, each hoist being provided with a smooth double drum approximately 4 feet in diameter with 24-inch face.

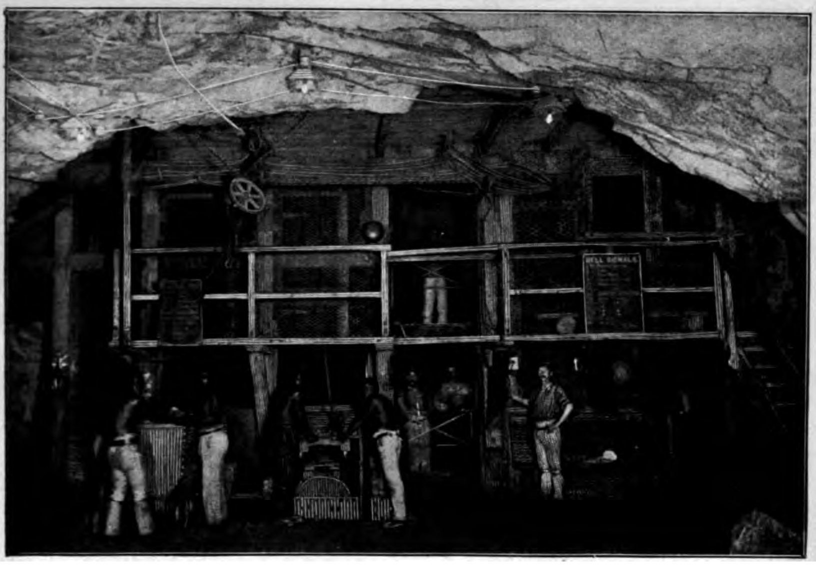
The smaller hoists are operated by the same type of motors hauling an unbalanced load of 600 pounds. The balance load comprises a cage of 800 pounds and a truck of 1,200 pounds, the counterbalance weight being 2,600 pounds. This load is started, raised, and stopped in 20 seconds. The small hoists operate continuously for 12 hours per day. Suitable individual switchboards are provided for the control of all the hoists.

There are now being constructed six Baldwin-Westinghouse mining locomotives, each for hauling loaded trains over a uniform down grade of 0.75 to 1.00 per cent, the load being down-grade. Each of these locomotives is provided with 20-inch wheels, over-all length not including bumpers being 9 feet 6 inches, the wheel base 4 feet. These locomotives operate on a track of 18-inch gauge and the electrical equipment compirses two motors of approximately 10 horse power each, and the usual controllers, automatic car circuit breakers. lightning arresters, diverters, etc. The gauge is 18 inches and the motors have been mounted clear of the wheels. The motor pinion gears in the usual way with an intermediate gear wheel, the journals of the shaft carrying this gear wheel running in boxes working on pedestals over the main journal boxes of the locomotive, and rigidly connected to them. Consequently the locomotive frame, which is supported on springs in the usual manner, is free to rise and fall on the axles without disengaging the gears. The motors themselves are suspended on the shaft of the intermediate gear as though these were the ordinary wheel axles, the usual nose suspension being used.

Each train comprises twenty trucks, each truck when full weighing 3,200 pounds, the empty truck weighing 1,200 pounds. The speed of these locomotives will be about 8 miles per hour on the level track when exerting full-load tractive effort. The rails are 35 and 45 pounds per yard, and the limiting width of these locomotives is 3 feet 6 inches. Each locomotive is capable of exerting a draw-bar pull of 1,100 pounds on the level.

The motors in use in and about the mines are for the larger part wound for 220 volts, 120 volts however being used in places where it is not deemed advisable to adopt the higher voltage.

The power generated at 5,000 volts, three-phase, is carried by means of triple lead and armored covered cables, which have previously been subjected to an insulation test of 10,000 volts between

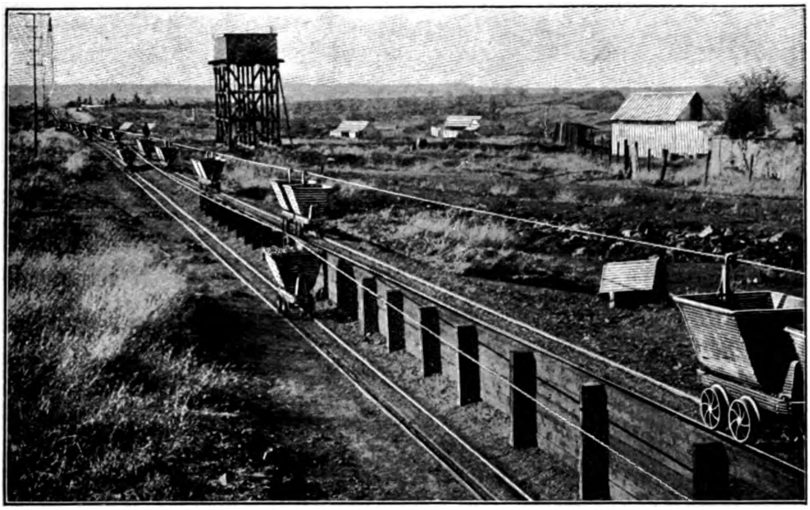


A SHAFT STATION.

conductors and between each conductor and the lead sheathing, to the various sub-stations, all of which are located below ground in the mines. There are nine of these underground sub-stations, in each of which are installed high-tension and low-tension switchboards. The high-tension switchboards receive the current at 5,000 volts from the transmission cables, pass it through measuring instruments and automatically operated oil switches, through fuse blocks to the primary of transformers. These high-tension boards are each two to three panels in size. The low-tension voltage of these transformers is 240 or 120 volts, as the case may be, this current passing direct to the low-tension boards located in the same sub-station. The following names of the sub-stations, together with the previous description of the mines, will indicate the location as well as the class of work performed by the motors fed by these respective sub-stations.

1—Combined haulage (mining locomotives.)
2—De Beers Mine.
3—Pulsators.
4—Work shops.
5—Kimberley Mine.
6—De Beers No. 4 washing machine.
7—Sanatorium.
8—Bultfontein mines.
9—Premier mines.

Sub-stations 2, 5, 8 and 9 have installed in each of them two low-tension switchboards, one controlling the circuits supplying power and



MECHANICAL HAULAGE, KIMBERLEY MINE.

light on the surface in that vicinity and known as the Surface Distributing Boards, and the other controlling the power and light underground at that place, known as the Underground Distributing Boards. Both the high-tension and the low-tension boards are made up of marble panels supported and fastened together by suitable iron frame work. From the low-tension boards the circuits running to the surface supplying lights and motors are 240 volts, whereas the underground circuits are 120 volts.

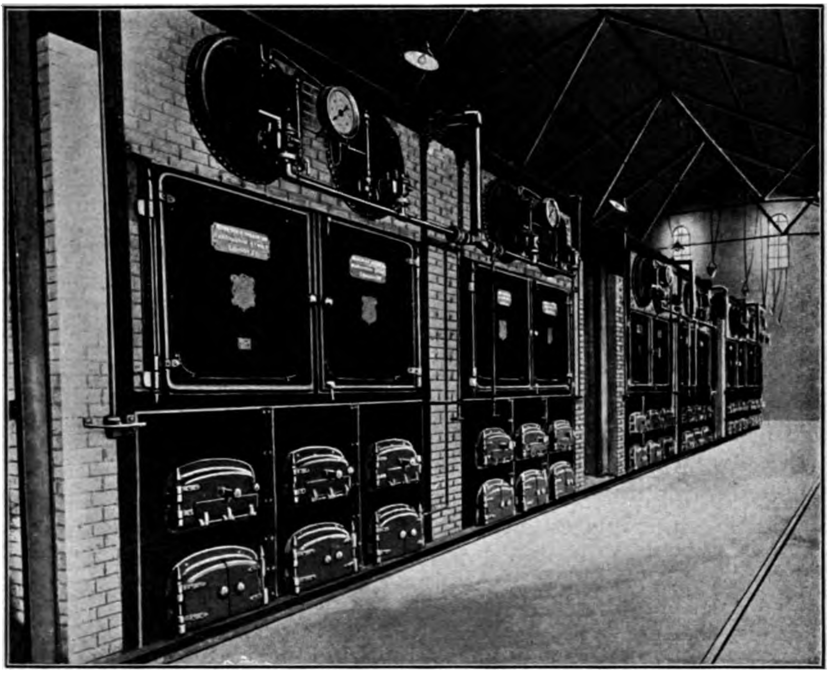
In sub-station 8 and 9, in addition to the usual lighting and power circuits on the switchboards, there is installed and controlled on the low-tension board in each station a motor-generator set, consisting of a 50-horse-power alternating-current induction motor, 220 volts, coupled to and mounted on a common base with a 37.5 kilowatt compound-wound direct-current generator, 220-250-volts, this power being used to operate the electric locomotives referred to later.

The motors at present installed and receiving their current from these sub-stations are all of the three-phase induction type, 220 volts, 6,000 alternations, and of the following numbers and capacities:

2—1-horse-power
5—3 " "
10—5 " "
3—7.5 " "
8—10-horse-power
8—15 " "
3—30 " "
1—50 " "

These motors are all provided with starting devices located near the motors they operate, an ammeter and fuses also being inserted in the circuit of each motor to indicate its load. These ammeters, fuses, and starting switches are mounted on little individual motor panels. In addition to the vast number of incandescent lamps fed from these various sub-stations, there is installed in sub-station 1 a motor for driving an arc lighting machine with its exciter.

Polyphase integrating wattmeters are installed on the high-tension switchboards for measuring the power consumed at the respective sub-stations. The lighting and power circuits on the low-tension switchboard have ammeters in them, these circuits also being fused.



SIX BABCOCK & WILCOX BOILERS, 2,531 SQ. FT. HEATING SURFACE EACH, DE BEERS MINE.

The De Beers Consolidated Mines, Ltd., have not, however, confined the introduction of electrical apparatus to electric motors and machines for their mining properties only. Realizing the advantages and saving resulting from the use of modern alternating-current induction motors, they have equipped throughout electrically their various other industrial holdings, such as coal mines, cold-storage houses, and a large new explosive works, each of which is referred to here briefly.

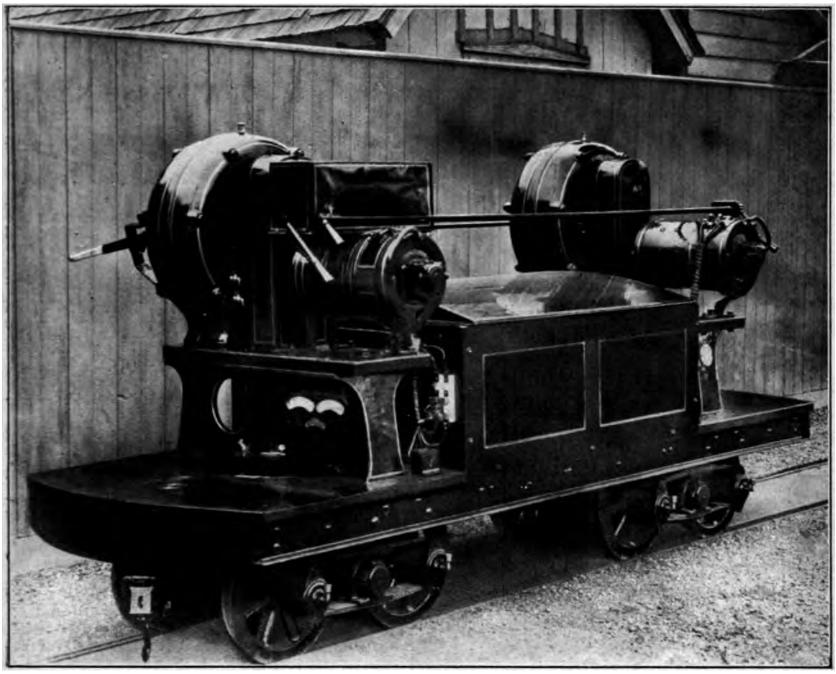
The Indwe Railway Coal & Land Company is in part owned by, and supplies the coal for, the De Beers Consolidated Mines, this company representing an asset of about $417,000. The output of this mine is about 12,000 tons monthly, the De Beers Company taking about 5,500 tons monthly on an average. The De Beers Company also consume about 1,000 tons monthly, taken from the mines of the Stormberg District. Formerly all the coal consumed by the De Beers Company was purchased from England at a very high cost. Recently, however, the Indwe coal has been used and found very satisfactory; its calorific power however is only about 60 per cent. of that of Welsh coal. It is only recently that this mine has been worked extensively. Troubles existing during the recent South African war even necessitated the use of wood, which was obtained from the north, the resultant cost being about twice that of coal.

The lighting and power for this plant is supplied from a power house, in which are installed two 150-kilowatt Westinghouse engine generator sets, the engines being of the compound vertical type working on a steam pressure of 100 pounds and making 250 revolutions, and adapted to work either condensing or non-condensing. The generators are mounted on the extended bed-plates of these engines and provided with outboard bearings. They are compound-wound for 500 to 550 volts direct current, this current being principally for supplying power to the mining locomotives used in and about the mines.

There is also installed in this plant a booster set for increasing the voltage of the feeder circuit running to the Byrne mine. This set consists of a 19.5-horse-power direct-current 500-volt motor direct connected to and mounted on a common base with a 11.25-kilowatt series-wound booster generator of 90 amperes capacity, 125 volts. These machines operate at a speed of 1,175 revolutions. This station is also provided with a switchboard for the control of the generators, four outgoing feeder circuits, and the booster. At the Byrne Mine a receiving switchboard is placed, comprising one receiving panel and a panel for two feeder circuits.

From the 150-kilowatt generator are operated five mining locomotives of the latest and most improved type. The gauge of the track is 2 feet 6 inches and the working load consists of 15 trucks of 1,800 pounds each with their load, the draw-bar pull being 1,200 pounds on the level. These locomotives make 8 miles per hour on level track when developing full-load tractive effort. The weight of rails in these mines is 20 pounds per yard, the average height of tunnel being 6 feet. The length of railroad controlled by this company is approximately 60 miles.

Among the electric locomotives used in the De Beers plants, men-



THE C. W. HUNT ELECTRIC LOCOMOTIVE.

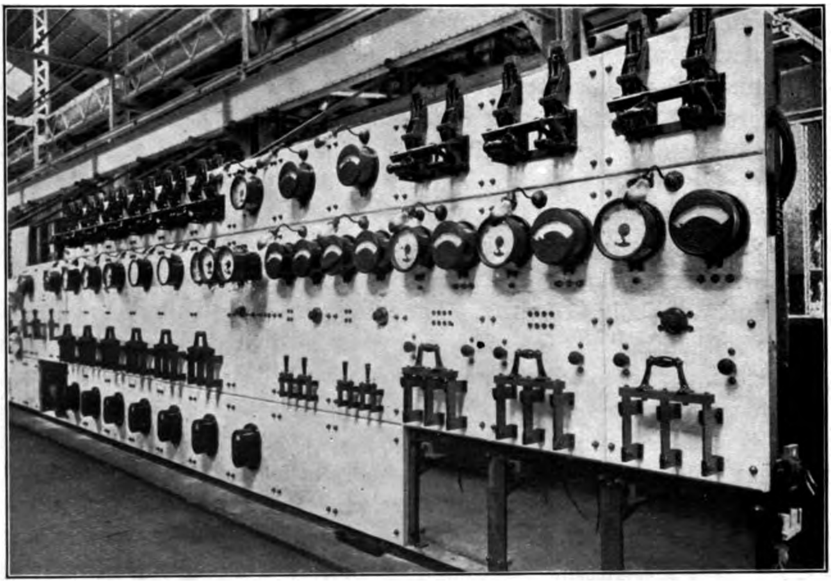
tion may be made of one 5-ton locomotive manufactured by the C. W. Hunt Company, fitted with storage batteries and equipped with two Westinghouse vehicle motors. It is arranged with double truck, the motors and batteries being mounted above the trucks and the axle chain-driven. This locomotive will haul 50 tons on a level. The total voltage on the motors is 100 volts, the battery being divided for charging on a 60-volt circuit.

The De Beers Company also own a large interest in the Imperial Cold-Storage Company, and in 1902 absorbed the Australian Cold-Storage & Supply Company. The taking over of this branch of business by the De Beers Company was quite a departure from its regular business. It proved, however, to be a great help to the English during the war, and has since been a very valuable source of revenue to the Company. Not only this, but the local people have profited by being able to obtain meats and provisions at a much less cost than before its establishment. In this plant there is installed a 75-kilowatt generator supplying current to three 30-horse-power and two 40-horse-power 220-volt 7,200-alternation induction motors, this power being consumed in driving ammonia condensers, etc.

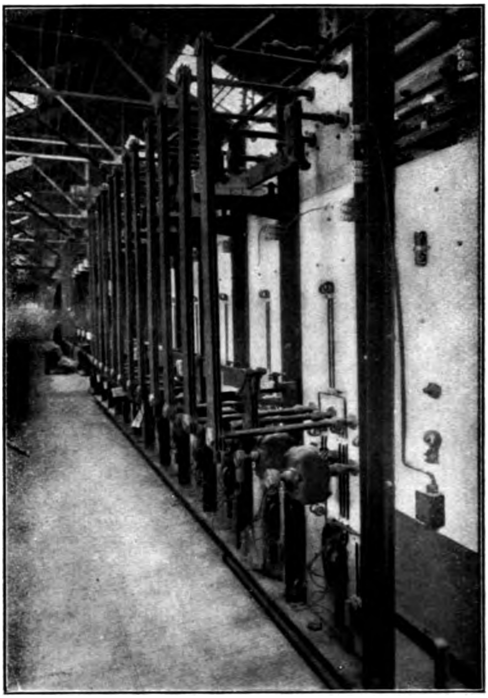
Probably one of the best equipped explosive factories in the world, and certainly the most modern, is the De Beers Explosive Works, which is equipped electrically throughout. In establishing this plant it was the company's intention to sell a great deal of their output to mining interests in Johannesburg and thereabout, and thereby earn a good revenue besides supplying all the needs of their own mines.

In the electrical generating station of this plant are installed three 300-kilowatt Westinghouse-Parsons steam-turbine generator outfits, made in England. They are supplied by steam at 150-pounds pressure and operate at a speed of 3,000 revolutions. These generators are two-pole, 6,000 alternations, three-phase, 440 volts. Most of the energy of these machines is consumed in motors. These turbo-generators are excited by two sets, one motor-driven and one steam-driven, each being capable of exciting the fields of all three generators.

A ten-panel switchboard is provided for the control of these three generators, the two exciters, and the motor driving the motor-exciter set, also controlling six feeder circuits each on a separate panel. These supply the various motor circuits in and about the explosive works, from which are operated some 100 to 125 constant and variable-speed induction motors. The work which these motors are called upon to perform is of an extremely varied nature and again well indicates the



FRONT OF SWITCHBOARD, DE BEERS EXPLOSIVE WORKS.

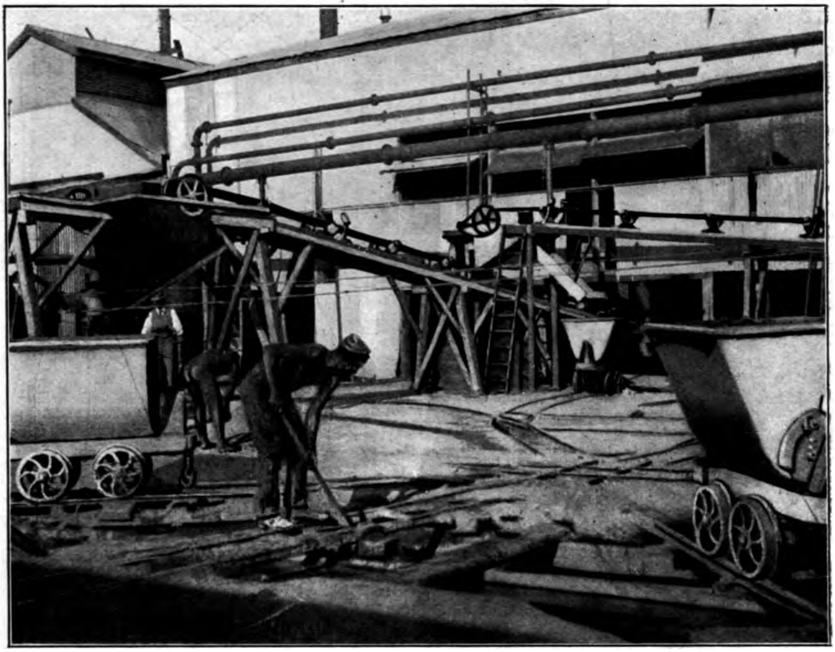


SWITCHBOARD, DE BEERS EXPLOSIVE WORKS.

many applications to which the modern alternating-current motor may be applied. The constant-speed motors are provided with oil-immersed auto-starters and gas-proof enclosed fuse blocks. The two-speed and variable-speed motors are provided with oil-immersed controllers and the same type of fuse blocks. These controllers are similar to the drum street-car type in appearance, being provided with starting notches and capable of reversing the motor where occasion requires. The two speeds of the two-speed motors are obtained by changing the combination of motor coils, such as changing from four to eight poles, by a proper combination of fingers and notches on the controller.

The variable-speed motors in this installation are constructed similarly to the induction motor, except that the rotating or secondary element is provided with a three-ring collector from which leads are run to the oil-immersed controllers connecting with suitable resistances. By this means a varying amount of resistance is inserted in the secondary winding of the motor, resulting in a variation of speeds.

As an example of this last-named motor, there is in service a 10-horse-power motor used to drive a vertical triplex Blake pump, the motor being geared to the pump and mounted on its extended bed plate. As it is necessary to vary the speed of the motor at least 50 per cent, this type of motor meets admirably the condition required and allows water to be supplied to the boiler as needed. In the boiler house are installed both steam and electrically driven pumps, each pump delivering 30,000 pounds of water per hour against a discharge head of 160 pounds per square inch at a piston speed of 100 feet per



ROBINS BELT CONVEYOR HANDLING BLUE GROUND AT THE DE BEERS MINE.

minute. As an example of the work done by motors of the two-speed type, reference might be made to a 60-horse-power motor operating an air compressor, which is capable of delivering 12 pounds, or about 320 cubic feet of free air, per minute against a discharge pressure of 80 pounds per square inch. The speed of compressor when working at rated capacity is 57 revolutions; it is belted from a jack shaft driven by the motor. This compressor has a Corliss inlet valve and a Riedler outlet valve, and is unique in that the Corliss valve is fitted with a triple gear so that only the amount of air which is required is taken into the compressor, and this automatically. Power-driven compressors as a rule either do no work through their unloading devices other than the friction of the machine, or do whole work against the receiver pressure. This brings extreme fluctuations on the motor; this trip gear is so arranged as to do away with these fluctuations. Further, this trip gear, when starting up, allows for the motor starting up with light load on the compressor—that is, if no trip occurs the inlet valve remains open during the whole of the forward and return stroke, so that the air is simply drawn in and blown back again through the same valve and consequently no work done. If the full capacity is required these valves are tripped and closed exactly at the end of the suction stroke, or at any other point according to the capacity required.

A variable speed motor also runs a Gurden Pump of Fraser & Chalmers make used as a circulating pump to circulate the water through the jackets of the compressor for cooling. This pump is under a suction of 2 feet 9 inches. The advantage of this pump over the ordinary centrifugal pump is that the centrifugal has to run at constant speed and requires a full bore of water to be constantly supplied to it. Further, it will not suck from the lift and must be continuously primed. This Gurden pump takes the water as it is supplied to it with a suction lift, and delivers the water according to the rate required, the speed of the motor, and therefore the speed of the pump, being variable. The capacity of this pump is 160 gallons per minute when running at 100 revolutions, although it can be run at a higher speed if required.

The refrigerating plant in this explosive works makes use of two 75-horse-power motors driving, by belts, ammonia compressors each capable of circulating 25 pounds of ammonia per minute when working against condenser pressure of 200 pounds.

As giving an idea of the varying uses which can be applied to these motors a table of the motors installed in this plant and the work performed by them, together with the horse-power capacity of each, is given on page 162.

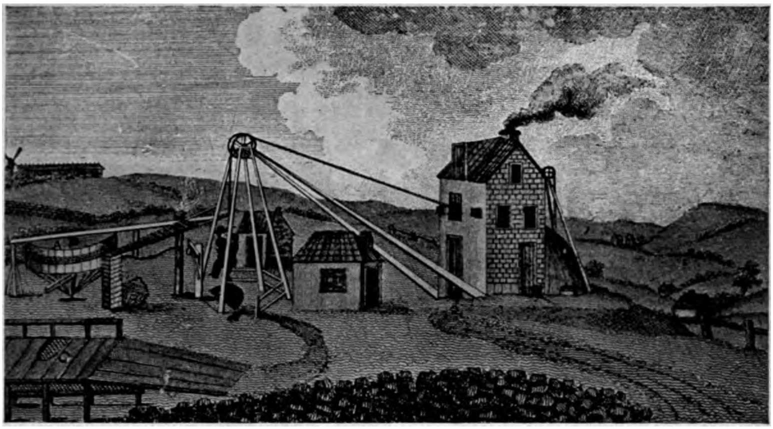
For obvious reasons, great care is necessary to prevent arcing or sparking in the explosive works, and this is entirely assured by the use of induction motors with fuses, starting devices, and controllers protected as described. Numerous transformers of the Westinghouse shell-type construction, of varying capacities, are used to reduce the voltage from 420 volts, the main line voltage, to 110 volts, that desired for the lighting service.

The transportation of all the above electrical apparatus from New York by water has been to Cape Town, Port Elizabeth, Durban, and East London. Most of the apparatus for the diamond mines plant was handled at Port Elizabeth, Algoa Bay, and that for the Explosive Works at Cape Town. The transportation by rail to destination has been over single track roads of 3 feet 6 inch gauge.

The devising of methods to overcome the many problems which have arisen and their successful execution is largely due to the present Manager, Mr. G. F. Williams, from whose recent book, "The Diamond Mines of South Africa," much of the above information is taken by courteous permission of the author and the publishers—the Macmillan Company.

LIST OF ELECTRIC MOTORS IN THE DE BEERS EXPLOSIVE WORKS INSTALLATION.

Location.	Drives.	No.	Horse power each.
Nitro-glycerine houses	Shafting	4	7½
Catchment system	Centrifugal pumps	3	3
Mixing houses	Shafting	9	10
Squirting houses	“	9	5
Olin Scott mixers	“	2	10
N. G. cooling system	Centrifugal pumps	2	2
Acid-cooling house	“ “	3	2
Nitrating house	3 Centrifugal pumps	1	20
“ “	3 Washing	1	10
“ “	2 Fans	2	3
Pulping house	2 Beating engines	2	30
“ “	2 Centrifugal pumps	2	5
“ “	2 Washing centrifugals	1	7½
Cotton-waste dry house	Fan	1	5
Cotton-waste dry house	Picker	1	7½
Wood-pulp dry house	Fan and seive	1	5
Cartridge house	Paper cutter	1	5
Two box houses	Nailing machine	2	5
Nit. soda dry house	Nitro wheel	1	5
“ “ “ “	Fan	1	5
“ “ “ “	Nitre mills	1	20
Machine shop	Shafting	1	5
Carpenter shop	“	1	20
Blacksmith shop	Blower	1	1
Foundry	Shafting	1	10
Boiler shop	“	1	10
Brick factory	“	1	40
Rock crusher	Rock crusher	1	7½
Sul. acid works	Shafting	2	40
Heating systems	Centrifugal pump	3	1
Rain-water service	“ “	1	1
“ “ “	“ “	1	2
Refrigeration plant	Am. compressor	Total H. P.	150
“ “	Auxiliary ap.	“ “	20
Power house	Air compressor	“ “	60
“ “	Cooling tower	“ “	30
“ “	Air pump	“ “	15
“ “	Water circuit pump	“ “	50
“ “	Boiler feed pump	“ “	5
“ “	Economizer scrapers	“ “	2
“ “	Coal crushers	“ “	10
“ “	Conveyers	“ “	10



AN EARLY BRITISH COLLIERY. SKETCH OF THE "HARRINGTON MILL PITT COLLIERY." Reproduction of frontispiece of old treatise on Coal Mining in Durham and Northumberland, by Mr. J. H. H. Holmes, 1816.

THE COAL-MINING INDUSTRY OF THE UNITED KINGDOM.

By R. A. S. Redmayne.

II. RECENT DEVELOPMENT IN BRITISH COAL-MINING.

In the introduction to Professor Redmayne's first article, which appeared in our issue for October, it was pointed out that Great Britain's early and systematic development of her coal resources, in connection with her enormous industrial and commercial expansion, had given her a long pre-eminence as a fuel producer. Professor Redmayne addressed himself first to the historical review of the era of her undisputed supremacy, and to the early effects of machinery in the vast betterment of the condition of the workers. The paper now presented follows the subject through the later epoch of scientific working and the extending use of power-driven machinery, under the increasingly apparent pressure of competition from the vast coal output of newer countries. This leads naturally to the third and concluding article, to appear next month, which will deal with the economic aspects of the problem and especially the rise and prospects of the American export coal trade.—The Editors.

THE nineteenth century has been well named the "age of coal," and certainly the early part of the century witnessed developments which in magnitude far outweighed any of those of the preceding history of the trade.

With increased and increasing demand came the necessity of opening out lower seams, and deeper shafts meant a heavier capital expenditure in colliery enterprise. It is remarkable how little the outside public realise of the great difficulties that often have to be overcome in sinking—such as passing through water-bearing strata or running sands—or of the enormous cost entailed by some colliery developments.

As early as 1829 Mr. John Buddle, in giving evidence before the

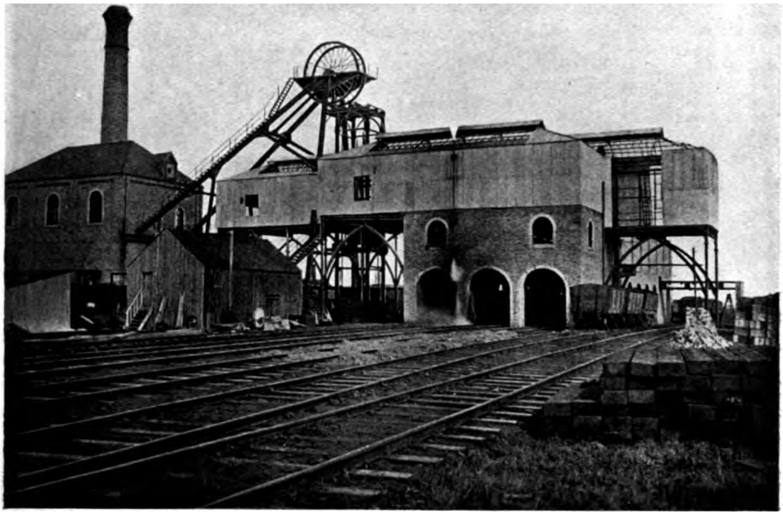


FIG. 2. A MODERN BRITISH COLLIERY. ASHINGTON COLLIERY, NORTHUMBERLAND.

House of Lords, declared that the cost of sinking, even then, was frequently £10,000 to £15,000; and Mr. J. T. Taylor stated before a select committee on rating of mines in 1857 that at Haswell Colliery in the county of Durham, £40,000 was expended in contending with a quicksand, and that the shaft had ultimately to be abandoned. At Murton Colliery, a few miles distant from Haswell, £300,000 was expended in sinking, the quantity of water pumped during the operation of sinking through the overlying magnesian limestone bed amounting to an average of 9,306 gallons per minute from a depth of 540 feet; and the three shafts ultimately reached the Hulton seam, at a depth of 1,488 feet from the surface, in April 1843. Many deep and costly sinkings—several much deeper than in the last instance—have been put down since the Murton Winning, but none, I believe, at a greater expenditure of capital, owing, doubtless, to the greatly improved methods now employed in carrying out such operations through watery strata—notably the Kind-Chaudron system whereby the shaft is *bored* out and the side protected by metal cylinders lowered from the surface; and the Poetsch or Gobert methods whereby the water is frozen in the "running" sand, or other water-bearing stratum, and the shaft sunk through the solid mass. The pits at Whitburn Colliery, near Monkwearmouth, County Durham, were put down through the magnesian limestone by the former method, and part of the New Winning at

Washington Colliery, in the same county, was last year carried out by means of the Poetsch system of freezing the ground.

The question of waste in working coal is one of ever increasing importance. Indeed, the requirements in coal mining may be epitomised as the production of the greatest possible quantity of coal from a given area, in the best possible condition, at the lowest possible cost compatible with safety to life and property. And as bearing upon this, a brief survey of the modes of working coal in Great Britain will not be amiss. The methods are four, of which there are many modifications.

1.—The "bord and pillar," or "stoop and room" method, mostly in vogue in the Great Northern coalfield and in Scotland, consists, briefly, in dividing up the mine into districts or panels (panel work) of pillars, (see Figure 3) the districts being separated by barriers of solid coal: this is called the first working, the pillars and barriers being removed in what is termed the second working.

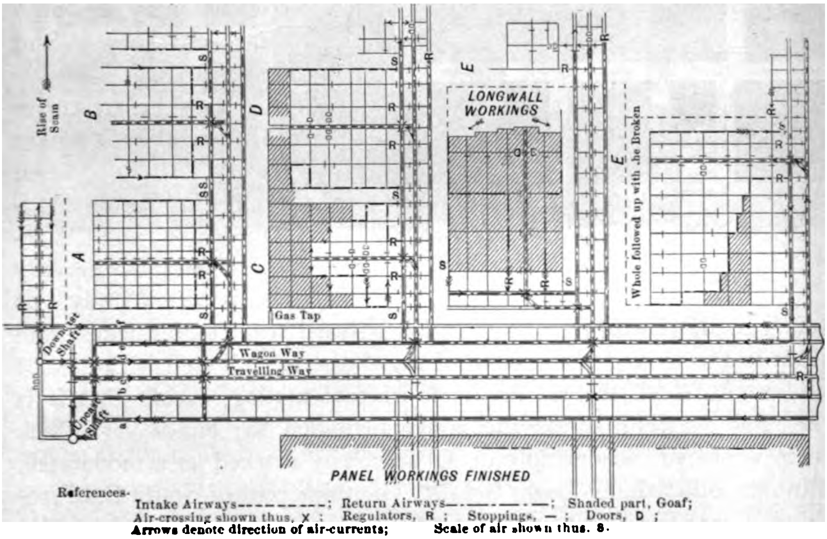

Rise of Seam
B
D
E
LONGWALL WORKINGS
E
Whole followed up with the Broken
A
C
Gas Tap
Wagon Way
Travelling Way
Downcast Shaft
Upcast Shaft
PANEL WORKINGS FINISHED
References.
Intake Airways----------; Return Airways—-——-——·—; Shaded part, Goaf;
Air-crossing shown thus, X ; Regulators, R ; Stoppings, — ; Doors, D ;
Arrows denote direction of air-currents; Scale of air shown thus. 8.

FIG. 3. SKETCH PLAN OF A MINE WORKED ON THE PANEL SYSTEM.

2.—Closely connected with this mode* is that known as the "stall method"—"single or double stall"—chiefly practised in South Wales and particularly so in the anthracite district of the coalfield. In other parts of the field it is being superceded by longwall. The manner of working is to drive roads or stalls, usually about 12 yards wide, into the

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* The "stall" and the "square" methods of working may perhaps be regarded as modifications of the bord and pillar system.

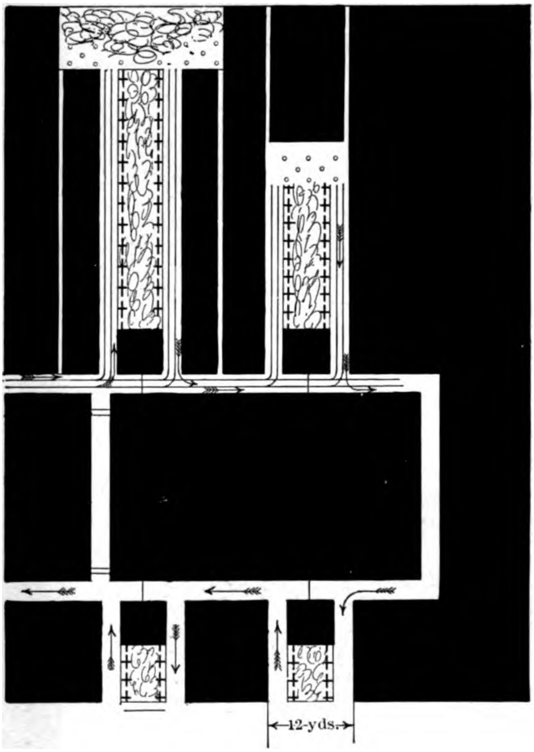
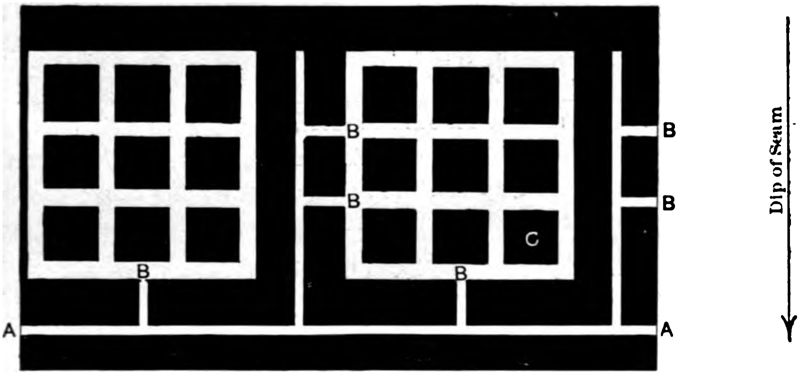


FIG. 4. DOUBLE STALL WORKING. ARROWS DENOTE DIRECTION OF VENTILATING CURRENT.

solid coal (Figure 4), an open road being kept in the case of double stall, along either side of the stall against the solid coal, for passage of men or haulage of coal; the roof in the middle portion is allowed to fall or is stowed with debris, the ribs between the stalls being worked back when each stall has attained its specified distance, which may be anything between 30 and 130 yards.

3.—The system known as "square work," in operation only in South Staffordshire and Warwickshire, is the only satisfactory way, as yet devised, of working the so-called 10-yard seam (the thickest coal seam in the United Kingdom) of those districts, though it cannot be said to fulfill all the requirements of coal mining, seeing that it is the most wasteful of all the systems alluded to; but a very thick seam is not so economically or satisfactorily worked as a moderately thin one, other things being equal. The thick coal of South Staffordshire varies from 8 to 12 yards in thickness, and is divided into a series of layers by thin "partings," the seam being, in reality, an agglomeration of many coal beds which further north exist as separate seams. The horse roads are made in the bottom coal, and the "side of work" driven out in the form of a parallelogram 50 yards or more in "the side," each "parallelogram" being divided from the adjoining one by a rib of coal 7 or 8 yards thick (see Figure 5). The roof coal is then cut down in beds according to the partings in the seam, small pillars being left to support the roof. Though these pillars and the ribs are left as small as possible, the loss of coal is nevertheless very great, oftentimes as much as 20 per cent.* Eventually each side of work when abandoned is dammed off to exclude the air and prevent the spontaneous combustion of the small coal or slack made by the crushing of the left pillars and ribs. The thick coal is very liable to spontaneous combustion and underground fires are of common occurrence in this field. As the thick coal is known to exist at a very much increased depth east and west of the great boundary downthrow faults, (and, indeed, is already being worked on the eastern side by the Hampstead and Sandwell Park collieries, and is being sunk to on the western side at Baggeridge), the difficulties of working will be aggravated by the great amount of crush due to the depth, and will in the near future tax the ingenuity of the mining engineers to the utmost.



AA Gateroad B Boltholes C Pillars
Scale 1.75 chains to 1 inch

FIG. 5. PLAN OF SOUTH STAFFORDSHIRE SQUARE WORK.

4.—The "longwall" system, (Figure 6) sometimes known as the Shropshire method of working, owing to its having been first carried out in that coalfield, is perhaps the method in most general use, and is especially suited to thin seams, seams having either a fireclay or ironstone roof or floor which is being worked simultaneously with the coal, or seams of coal containing interstratified bands of stone. The coal is removed entirely in one working, the vacancy packed with stone, and the haulage, travelling, and ventilating roads kept open through the waste ("goaf" or "gob"). In some cases, however, it has been

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* This refers only to the first working as here described; frequently, however, the ground is gone over again, and the pillars and ribs in a great measure removed. Indeed, the writer has been recently informed by a mining engineer, who has had many years' experience in working the thick coal by "square work," that in some instances he had practically recovered all the coal in a given area.

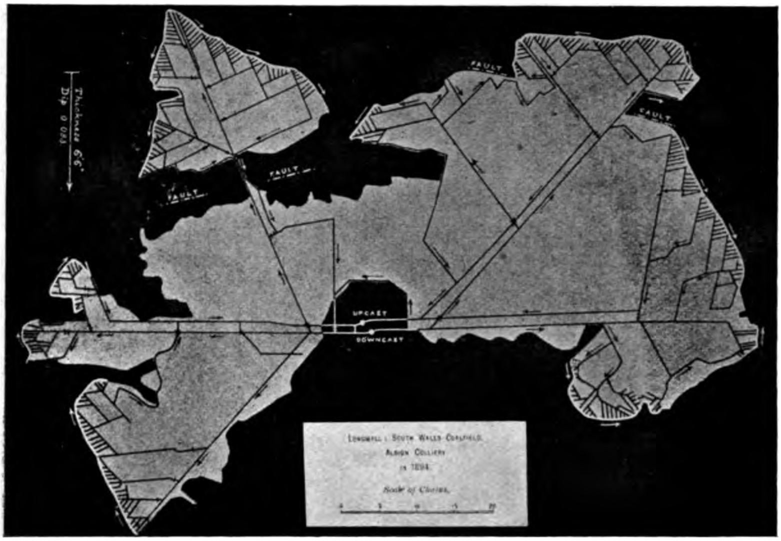

FIG. 6. PLAN OF LONGWALL SYSTEM OF WORKING.

deemed advisable to drive these roads out from the shafts to the boundary and work the longwall back to the shafts, this being known as "retreating" in contradistinction to the "advancing" system of longwall.

The "square" or "wide work" is by far the most wasteful of the methods of working coal, the "bord and pillar" and "stall" methods being very much less so, and although it is usual to allow in calculations 5 per cent. for loss of coal in working by these two last systems, it will be found that it is less than this in actual practice when either of these systems is well carried out. Longwall is the least wasteful system of all. Mr. James Dixon, in his presidential address before the members of the Institute of Mining Engineers last year, went into the subject of loss of coal in working. He compared the actual production with that calculated as being contained in certain areas worked over by bord and pillar and longwall in seams of various thicknesses. In one case three-quarters of the workings were on the bord and pillar system in four seams 3¾ to 7 feet thick, with good and bad roofs. The results were:—

By calculation the area contained 4,910,122 tons.
By output there were recovered 4,895,378 tons,

or a loss of only 0.3 per cent.

In another colliery where the workings of five seams from 2 to 4 feet thick were carried on entirely under the longwall system,

The results by calculation were 2,875,487 tons,
The results by output were 2,910,173 tons,
showing a gain of fully 1 per cent.*

Mr. Dixon arrived at the conclusion that in well managed workings on the bord and pillar system the loss in working is reduced to a very low percentage, whilst in longwall practically the whole of the coal contained in the excavated area is recovered. As the subject of waste of coal, in mining and in consumption, is before the Royal Coal Commission, their conclusions are being awaited with much interest.

Whereas the slack or small coal used to be left underground, and, therefore, was not included in the earlier computations of the annual output of coal from the United Kingdom, little or none of it is now left, as small coal is in much demand for manufacturing, coking, and other purposes.

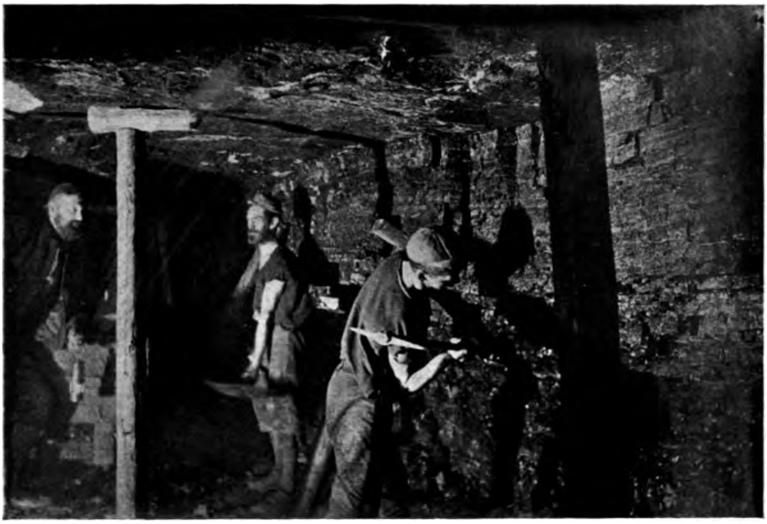

FIG 7. MINERS WORKING A LONGWALL FACE IN A THICK SEAM (6 FEET).

Not only may it be said that the latter half of the nineteenth century witnessed considerable improvements as to economy in modes of working and efficiency of underground ventilation, as well as in respect to winding, haulage, pumping and ventilating machinery, and the application of compressed air to mining operations, and in colliery administration generally, but it was also marked by the introduction of means rendering possible very considerable saving in the consumption of fuel, and also in the utilisation of classes of coal hitherto regarded as of small value. Coal which up to this time had been debarred from the markets came to be worked, leading to colliery developments in fields which had been more or less neglected.

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* Of course a good deal turns on the manner of calculating the contents of a coal seam over a given area, but given the average thickness of the seam, and the specific gravity of the coal, the calculated results should be very near to actuality.

The extent and relative positions of the British coalfields are shown on the accompanying map, Figure 7, in large measure a copy of that submitted by Professor Hull to the last Royal Coal Commission and published by them in their report of 1871.

Professor Hull has divided the coalfields as follows, and his arrangement is reproduced here as being the most convenient.

I. ENGLISH COALFIELDS.

Midland Group. 1, North Staffordshire; 2, South Staffordshire; 3, Leicestershire; 4, Warwickshire.

North Midland Group. 1, Yorkshire, Derbyshire, and Nottinghamshire.

Great Northern Group. 1, Durham and Northumberland; 2, Cumberland.

North-Western Group. 1, Lancashire and East Cheshire; 2, Coalbrookdale (or Shropshire); 3, Forest of Wyre.

Western Group. 1, Bristol and Somersetshire; 2, Forest of Dean.

II. WELSH COAL FIELD.

1, South Wales; 2, Denbighshire; 3, Flintshire.

III. SCOTTISH COAL FIELDS.

1, The Clyde Basin; 2, Midlothian; 3, Haddingtonshire; 4, Fifeshire; 5, Ayrshire; 6, Leshmahagow; 7, Canobie.

To which must be added, though they are not of great significance:—

IV. THE IRISH COAL FIELDS.

1, Northern Group.

2, Southern Group.

It is probable that the coalfields of Great Britain are in the majority of cases of the same age geologically, and at one time constituted one continuous coal area, now, through the agency of denudation, forming detached areas; yet as to the nature and quality of the coal considerable diversity exists, and this variation coupled with the abundance of the different qualities has done more than anything else to establish British commercial greatness.

Coal mining until comparatively recent times was carried on chiefly in the Great Northern or Newcastle Field, Staffordshire, and Scotland,

and to some extent in South Wales, where the broken character of the country with outcropping coal seams in the valleys allowed of easy mining; the more general development of this field, however, came later. Gradually the other coalfields began to be developed, so that at the present time, whilst some of the coal-mining disricts may be regarded as progressive areas, that is to say, have not yet attained the zenith of their productive development, others are either stationary or retrogressive. Some of these fields, such as the Great Northern field, may show increased annual production, but this is due rather to the augmentation of the output from existing collieries than to any further extension of development.

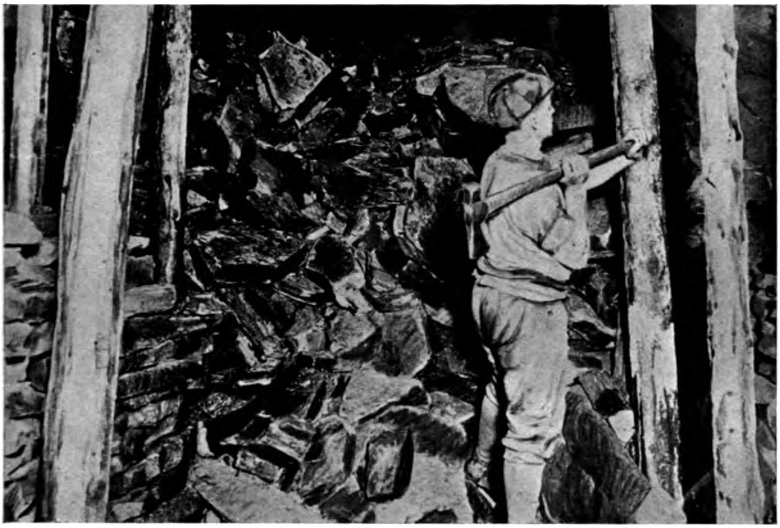

FIG. 8. "DEPUTY" ENGAGED IN DRAWING TIMBER IN A LIFT.

Those of the proved coalfields chiefly allowing of further colliery expansion are the North Midland and South Wales fields, and part of the Midland field; but even these will, within a comparatively short time, be fully exploited and will have reached the zenith of their development, leaving only the hidden coalfields for the consideration of those desirous of opening out new collieries.

Allusion has been made to the great variety of coal mined in the United Kingdom, and it may be further added that this variation in quality is peculiar also to individual fields. For instance, good coking coal is mined near the banks of the River Tyne, west of Newcastle, yet close to Newcastle itself the celebrated Wallsend household coal is produced. What is said to be the finest coke in Europe is made from coal worked in the western and south-western portion of the Durham part of the field, yet good gas and first-class house coal are raised from the colleries in the central and eastern districts.

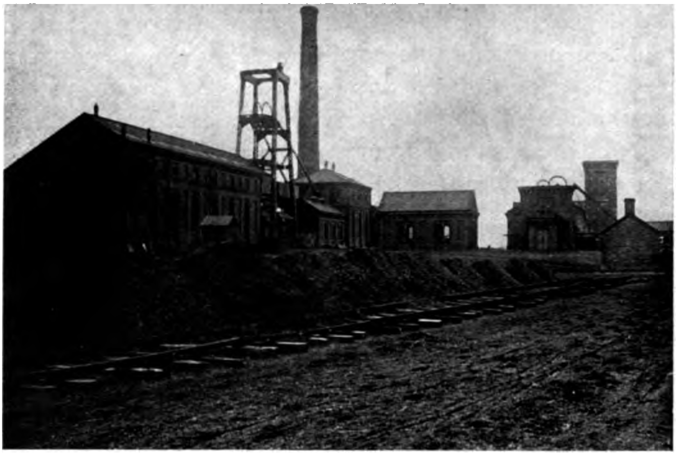

FIG. 9. NEW HARTLEY COLLIERY, NORTHUMBERLAND. A MODERN BRITISH PLANT.

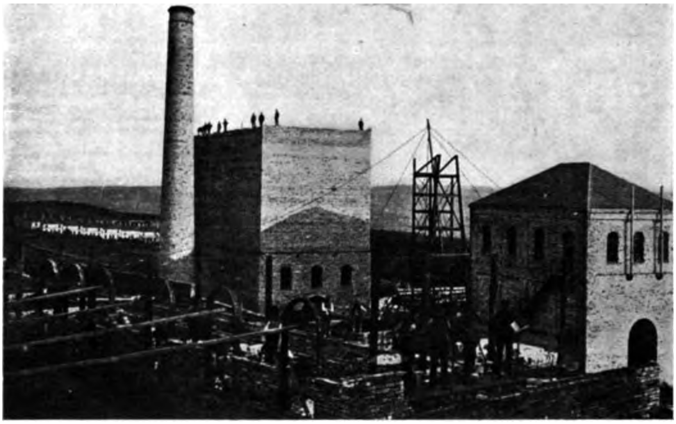

FIG. 10. COLLIERY HEAPSTEAD IN COURSE OF ERECTION.

The chief steam-coal producing districts are South Wales, Northumberland, some of the Scottish fields, and to some extent also Lancashire and North Staffordshire, and Yorkshire; but the Midland fields yield, principally, house, manufacturing, and iron-smelting coals, as well as gas and coking coals.

The quality of British steam coal, especially that derived from the

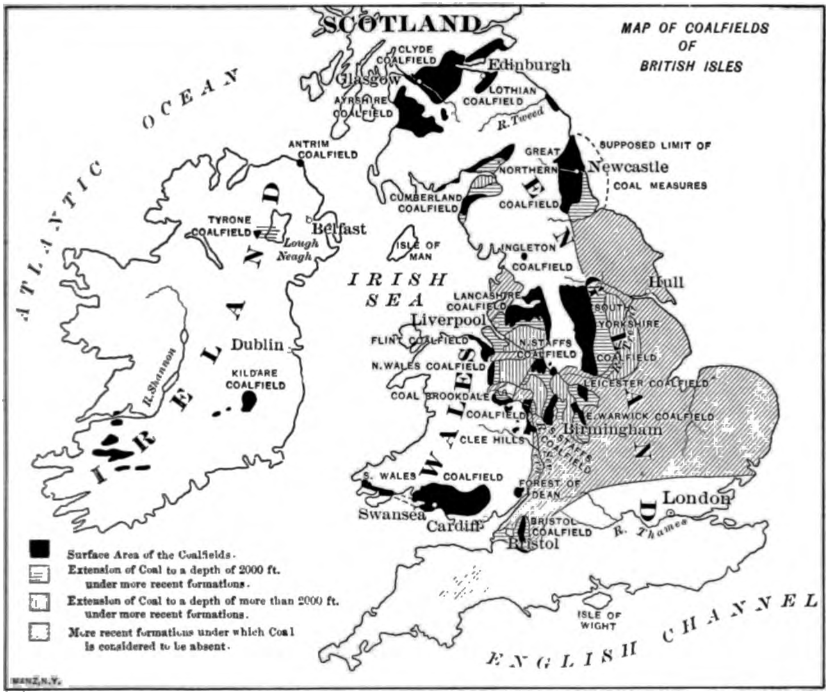

FIG. II. THE COAL-FIELD AREAS OF GREAT BRITAIN.

central part of Glamorganshire in the South Wales coalfield, is regarded as superior to all other steam coal at present in the markets of the world.

The South Wales coalfield, with the exception of the Clyde basin, is the largest in the United Kingdom, taking into consideration only the exposed portion of the latter field (see map, Figure 7). It is also remarkable for the great variety it presents in the character of its seams. In Monmouthshire these are bituminous, but become less so* towards the south-west, until in Mid-Glamorgan they constitute the smokeless steam coal used in the Royal and other navies. Towards the west (Pembrokeshire) the seams pass into anthracite.

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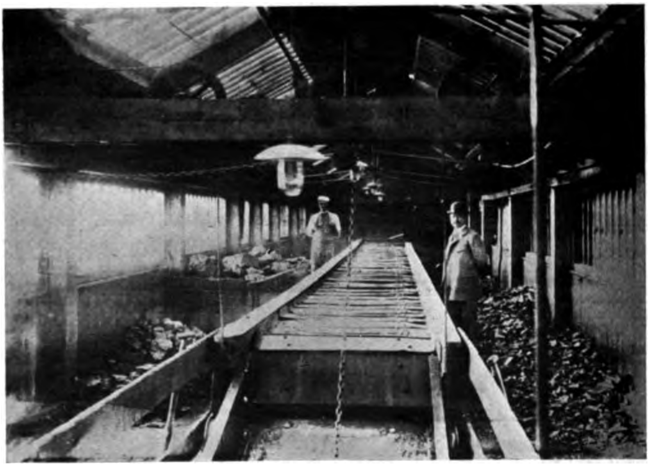
* A coal containing a high percentage of volatile hydrocarbons—that is, a bituminous coal—is sometimes spoken of as a "fat" coal, whilst a coal possessing a low percentage of volatile matter, but a high percentage of fixed carbon, is alluded to as a "dry" or steam coal, thus:—

An anthracite..............		would contain	88 to 92	per cent of coke	and	12-8	volatile matter.
A semi-bituminous or steam coal	"	"	82 to 88	"	"	18-12	" "
A bituminous coal	Clear burning	"	74 to 82	"	"	26-18	" "
	Flaming "	"	68 to 74	"	"	32-26	" "
	Fuliginous "	"	60 to 68	"	"	40-32	" "
A gas coal........	" "	"	50 to 60	"	"	50-40	" "

The annual production from the several mining districts in millions of tons towards the close of the last century may be taken as follows:—

Scotland.	Fifeshire		5½ million tons.
	Lothian, Clyde and other coalfields		23¼ million tons.
	Ayrshire		4 million tons.
England.	Great Northern coalfield		45 million tons.
	Cumberland		2 million tons.
	Midland.	Yorkshire Derbyshire Nottingham Leicestershire	52 million tons.
England.	Lancashire		23½ million tons.
	N. & S. Staffordshire Warwickshire Shropshire Worcestershire Gloucestershire Forest of Dean Bristol		19½ million tons.
	Somerset		1 million tons.
	Monmouthshire		9½ million tons.
Wales.	North		29½ million tons.
	South		3 million tons.
Ireland.			1/10 million tons.



TRAVELLING BELT FOR SORTING COAL AT A BRITISH COLLIERY.

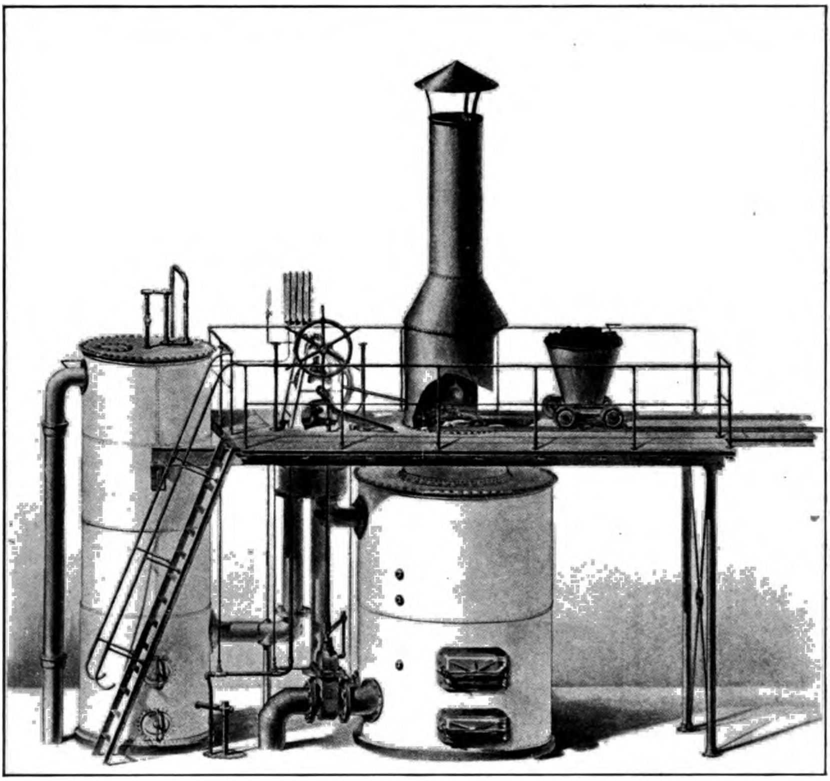
RECENT DEVELOPMENTS IN THE PRODUCTION OF WATER GAS.

By A. Humboldt Sexton.

One of the most important developments in the economy of power production in the near future is that connected with the extension of the use of gaseous fuel. One need only glance at the history of the internal-combustion engine during the past few years to appreciate one phase of this importance. It is this consideration which gives interest to the demonstration of any method of improving the economy and efficiency of fuel-gas manufacture, and amply justifies the description of a process that has made a successful and material advance in this direction.—The Editors.

DURING the last few years there have been great developments in the production and application of gaseous fuel. Some of these are as yet hardly beyond the experimental stage, but others have passed into the stage of assured success, and therefore are of great interest to the fuel user. Amongst these latter may be placed the latest of all, the new method of producing water gas which bears the name of Messrs. Dellwik and Fleischer. Received at first with a considerable amount of incredulity, largely due to its very simplicity, the process was soon found to be a success not only on the experimental scale but on the larger scale of practical application, and this is the real test of the value of any invention.

Water Gas.—It has been long known that when steam is passed over red-hot carbon, in the form of charcoal or coke (preferably the latter for practical purposes, as it is much cheaper) decomposition takes place and a combustible gas of high heating power is produced, but knowing the fact and making it of practical utility are two very different things, and often very far apart. The chemical change which takes place is very simple. Water is a compound of the two gases hydrogen and oxygen, the former of these when free being highly combustible. When the water, in the form of steam, is passed over hot carbon, the carbon acts as a reducing agent, exactly as it does when it is used for the reduction of metallic oxides, takes up the oxygen to form carbon monoxide, and liberates the element with which the oxygen was previously combined, in this case hydrogen, and both the



THE DELLWIK-FLEISCHER WATER-GAS APPARATUS.

hydrogen liberated and the carbon monoxide formed are combustible gases.

The chemical reaction may be expressed by the equation $C + H_2O = CO + 2H$ or it may be put in words, thus: twelve pounds of carbon will act on eighteen pounds of steam, will liberate two pounds of hydrogen and form twenty-eight pounds of carbon monoxide, so that by weight the composition of the gas produced will be

Hydrogen	2	6.67 per cent
Carbon-monoxide	28	93.33 " "

Hydrogen is however much lighter than carbon monoxide and the composition of the gas by volume will be

Hydrogen	50 per cent
Carbon-monoxide	50 " "
	100

Such a gas therefore will be entirely combustible, and as hydrogen has a very high calorific power (about 52,000 BTU)[*] compared with that of carbon monoxide (about 4,300 BTU) the comparatively small quantity of hydrogen will have great influence on the heating power of the gas, which will be about 7,500 BTU per pound, or about three times as high as an ordinary producer gas.

A gas of so high heating power will obviously be very useful for many purposes, and naturally many attempts have been made to produce it, but the difficulties in the way of economical production are very considerable.

The chemical change takes place readily enough at a high temperature, but it slackens or ceases altogether if the temperature be allowed to fall, and the reaction itself absorbs a large quantity of heat. The reaction consists of two distinct parts. For each pound of carbon burnt there will be the formation of 2 1/2 pounds of carbon monoxide and the decomposition of 1 1/2 pounds of steam with the liberation of 1/6 of a pound of hydrogen. The union of 1 pound of carbon with 1 1/3 pounds of oxygen to form 2 1/3 pounds of carbon monoxide will evolve about 4,300 BTU of heat, but the separation of 1/6 of a pound of hydrogen from the oxygen with which it was combined in the water will absorb about 8,700 BTU so that calling these positive and negative respectively the balance sheet would be.

	BTU.
Heat evolved in the formation of 2 1/3 pounds of carbon monoxide	4,300 +
Heat absorbed in the liberation of 1/6 pound of hydrogen.	8,700 —
Balance of heat absorbed for each pound of carbon consumed	4,400 —

So that every pound of carbon consumed will absorb 4,400 units of heat, and if the reaction is to be kept going this must be supplied as well as heat to compensate for the various accidental losses, such as by radiation carried away in the gas and otherwise.

It is obvious that the necessary heat may be supplied in two ways.

1.—The decomposition may be carried out in a closed vessel heated externally, and in this case the gas production might be continuous. No method based in this principle has however been successfully applied.

2.—The temperature may be raised by blowing air into the gas producer, thus burning some of the fuel, and as soon as the

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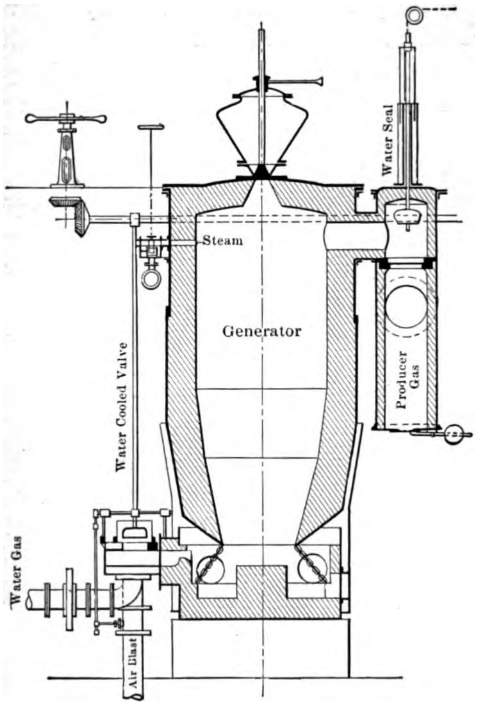
[*] Assuming the water formed to remain in the gaseous condition. The British Thermal Unit (BTU.) is the amount of heat required to raise 1 pound of water 1° F.



SECTIONAL DIAGRAM OF LOWE WATER-GAS PLANT.

temperature is high enough, cutting off the air supply and blowing in steam, usually in the reverse direction, the passage of the steam being continued till the temperature is reduced to a point at which the decomposition ceases or becomes slow, when the steam is cut off and air is again passed till the temperature is high enough. By this method the gas production must always be intermittent, periods of gas production alternating with periods of heating up. This is the method which has always been used in water-gas production.

History of Water Gas.—The date of the first attempt to make water gas for practical purpose is not known, but the first important patent seems to have been that of Lowe, taken out in 1875. Plant on the principle of this patent was soon created in America, in Great Britain, and on the Continent, and it came to be the recognised type of water-gas plant. The best known plant in Great Britain was probably that at the Leeds Forge though plant almost identical with this was erected in many other places.

It is an intermittent plant, heated by internal combustion, and consists of a cylindrical iron producer lined with fire-brick. Air is blown in and the water gas withdrawn at the bottom, the heating-up stage being therefore produced by an upward current of air whilst, steam being admitted at the top, the gas is made by a downward current of steam, the steam entering the coke where it is coolest and leaving where it is hottest.

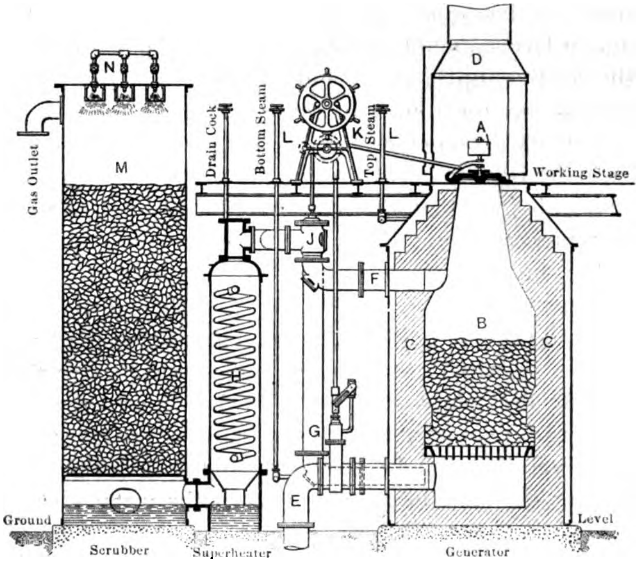
Owing to the thick layer of fuel and the large excess of coke present, the combustion in the heating-up stage only takes place to carbon monoxide, so that the gas escaping during this stage consists of carbon monoxide and nitrogen, and as it contains about 33 per cent. of the former gas, it is combustible and is a valuable fuel—indeed analyses of this "blow up" gas show it to be almost identical with producer gas made with only a small amount of steam. As the carbon is only burnt to carbon monoxide, the amount of heat evolved is small, and therefore a large amount of coke must be consumed in the heating up, and the heating up is slow—indeed, the usual rate is about 10 minutes heating up for four minutes gas making, and the yield of water gas is about 36,000 cubic feet per ton; roughly speaking, about two-thirds of the coke is burnt during the heating-up stage.

It is quite obvious that this consumption of fuel would heavily handicap the process unless the carbon-monoxide gas produced during the heating-up stage could be utilised in some way. Where this gas can be burnt direct in regenerative or other furnaces and the water gas passed into gas holders, the two gases being used separately, the process can be satisfactorily used, but in most cases this is not possible. Many attempts were made to modify the process in various ways, and Messrs. Loomis and Pettibone have an excellent apparatus, probably the best that can be designed on this principle, using the hot waste gases and also the sensible heat of the water gas for steam raising.

The radical defect of the usual type of intermittent, internal-combustion water-gas producer is the combustion of the coke during the heating-up stage to carbon monoxide only, thus utilising only about 4,300 units of heat for each pound of carbon consumed, and producing combustible gas which in many cases must be wasted. If the carbon could be burnt to carbon dioxide, each pound of carbon would evolve 14,540 units of heat, or rather more than three times as much as when burnt to carbon monoxide, and the escaping gases would only be useless products of combustion.

What was wanted, was evidently to burn the coke during the heating-up stage to carbon dioxide, and this Messrs. Dellwik and Fleischer succeeded in doing and thus made the production of water gas a practical success.

The Dellwik-Fleischer Process.—The conditions which must be arrived at when the production of carbon monoxide is desired, as in ordinary producer-gas making, are a thick layer of fuel, and therefore a large excess of carbon, and this is the condition in water-gas producers of the old type. Where carbon dioxide—i. e., complete combustion—is required, the conditions must be reversed, the excess of carbon must be small, and the thickness of the layer through which the air has to penetrate small, so that the quantity of oxygen present may be in excess of that required to burn the carbon to carbon dioxide.



DIAGRAMMATIC REPRESENTATION OF DELLWIK-FLEISCHER WATER-GAS PLANT.

These are the conditions attained by Messrs. Dellwik and Fleischer in their process. There is nothing peculiar in their producer. In the first producers designed there were side chambers into which the fuel was fed, but these have been abandoned in the later installations and the producers are now circular iron chambers lined with fire-brick, about 8 feet in diameter and 10 or 12 feet high, the fuel being supported in the usual way on fire-bars beneath which the air is blown. The fuel is supplied at the top, but instead of the producer being filled with coke, only a thin layer rests upon the bars.

The results of these changes are little short of marvellous. The heating up stage is reduced to 2 or 3 minutes, whilst the gas-making blow is increased to 8 to 10 minutes, the production of water gas for each ton of coke is more than doubled and the consumption of coke in heating up is therefore reduced by one half.

The cause of these differences will be readily seen from the following comparative table. It is taken from Mr. Dellwik's paper read before the Iron and Steel Institute in 1900 but the figures have been calculated into BTU from the centigrade results used in the paper.

C.	Old Method.	New Method.
1 lb. of C requires for combustion	To Co $\frac{16}{12}$ lbs. O	To Co_2 $\frac{32}{12}$ lbs. O
The O is accompanied by	4.32 lbs. N	8.64 lbs. N.
The products of combustion carry away at 1,260° F.	2045 BTU	3766 BTU
The heat of combustion of 1 lb. of C is	4,300	14,500
Balance available for heating fuel is	4300 — 2045 = 2255	14500 — 3766 = 10734
To make 30 lbs. of water gas, *i. e.,* to burn 12 lbs. of carbon, 51768 BTU will be required, therefore lbs. of C. must be consumed	$\frac{51768}{2255}$ = 22. 5 lbs.	$\frac{51768}{10736}$ = 4. 8 lbs.
Apart from loss by radiation, etc., there will be required for making 30 lbs. (753 cu. ft.) of water gas	12 + 22.5 = 34.5 lbs. C.	12 + 4.8 = 16.8 lb. C.
Or per lb. of C. is produced ...	21.7 cu. ft. water gas.	4.47 cu. ft. water gas.
As water gas of theoretical composition contains 290 BTU per cubic foot, there is utilised in water gas from 1 lb. C.	6293 BTU	12963 BTU
Which is equal to	48 per cent, of the total heat of the carbon.	92.5 per cent. of the total heat of the carbon.

These figures are quite near enough to form a basis of comparison, though they cannot be taken as being absolutely correct; for instance, the gas will probably leave the producer at a lower temperature during the heating-up stage under the old process than under the new, and on the other hand, the heating-up stage being much shorter, the loss by radiation should be less during the new process than the old. At any rate, the main features of the new method are sufficiently well marked: the quantity of water gas obtained per pound of fuel is about double, and the heating power of the gas from a given weight of fuel will also, therefore, be much larger; there is no loss of combustible gas, the products of combustion being quite valueless except for the serviceable heat which they carry away, which no doubt if found advisable might be utilised for steam raising as in the Loomis-Pettibone plant, or in some other way.

It may be remarked that the efficiency as shown in the table—that is, the proportion of the heating power of the fuel which can be obtained by the combustion of the gas—is larger than by any other process of fuel-gas making. In ordinary gas producers the efficiency calculated on similar lines is usually about 80 per cent.

Practical tests do not, of course, give as high an efficiency, because certain sources of loss are not taken into account in the calculations, but these are much the same in all gas producers. Practical tests quoted by Mr. Dellwik in his paper give efficiencies from 75.2 to 81.3 per cent.

A certain quanity of fuel will of course be required to raise steam, and this may be taken as about 1/5 of that used in the producer, but this might perhaps be reduced by using the sensible heat of the gas for steam raising or heating the boiler water.

Mr. Dellwik quotes some experiments of Prof. V. B. Lewes.

> "1,000 cubic feet of water gas, containing 15 pounds of carbon, are obtained by a total expenditure of 29 pounds of carbon, so that over 51 per cent. of the carbon is obtained in the gaseous form, whilst the expenditure of the other 49 per cent. results in the hydrogen of the water gas.
>
> "The coke used in the experiments made contained 87.56 per cent. of carbon, or 1,961.3 pounds per ton, equal to 15,876,307 thermal units C.° (28,577,352 BTU), and this amount yielded 77,241 cubic feet of water gas. The specific gravity, as taken by the Lux balance, was .5365, and its gross calorific value as determined by Junkers calorimeter was 4,089 thermal units (7,360.2 BTU). Hence the calorific value of the water gas from a ton of coke was 13,033,059.8 thermal units (23,459,507.2 BTU), or over 82 per cent. of the heating value of the total coke used in both generator and boiler.
>
> "From this calculation 20 per cent. of the coke has been taken as used for raising steam, but in a large installation this figure could be reduced and the percentage of the total heating value of the coke obtained in the gas slightly raised. The labour will be less than with the ordinary process, as less fuel has to be handled."

The water gas produced by any process is of course not of quite as good a quality as that shown by theory, because the temperature falls towards the end of the process and thus a small amount of carbon dioxide may be added to the gas, and also the producer at the moment of reversal is filled with gas consisting of carbon dioxide and nitrogen which is thus mixed with the producer gas. This, however, slightly increases its volume and does not to any considerable extent lessen its value.

The following analysis of water gas is given by Mr. Dellwik and will give an idea of its composition in practice.

Hydrogen	51	per cent.
Carbon monoxide	42	" "
Marsh gas	.5	" "
Carbon dioxide	4.0	" "
Nitrogen	2.5	" "

so that 93.5 per cent. of the gas is combustible. The gas burns with a non-luminous blue flame, whence it is called "blue gas," and the flame has a very high temperature.

The plant required is comparatively simple. The producer is circular and of the bar bottom type and is charged at the top by means of suitable iron trucks, about 2 cwt. of coke being added at a time. The producer is so arranged that the steam can be blown in and the gas drawn off either above or below the fuel, and in practice it is worked alternately in each direction, as this is found to give more uniform heating. The gas is passed to a gas holder, this being always necessary in the case of intermittent methods of gas production, and the products of combustion during the heating stage are allowed to escape.

An ingenious system of valves is used so as to make it impossible to open the air supply whilst the producer is in connection with the gas holder. The progress of the gas making is watched by burning a small jet of the blue gas at a burner on the top of the producer, and this gives instant indication of the slackening of the decomposition of the steam, which is the signal for stopping gas production and heating up again.

Water gas can be used for any purpose for which gaseous fuel is required, though it is perhaps too much to say that it is best suited for all, but certainly in all cases where a very high temperature is required is unsurpassed.

Owing to the non-luminosity of the flame of water gas, it cannot be used directly for illuminating purposes, but it can be used quite readily and strange to say this seems to be one of the most promising fields for the use of the gas.

In the early days of water-gas making it was used by making the non-luminous flame heat mantles or combs of magnesia, and whilst the light given was in many ways excellent the friability of the combs militated against its success.

In ordinary coal gas, however, the illuminating constituents are present only in small quantity, the larger proportion being carbon monoxide and hydrogen, but in somewhat different proportions from those in which they are present in water gas. Indeed, a high heating power is essential to a good illuminating gas, as the separated carbon to which the flame owes its luminosity must be heated to a high temperature, in order to obtain high luminosity.

Prof. Lewes has devised a process of using water-gas in conjunction with coal gas by passing the former through the retorts, and this has been tried at Tipton Staff with great success. The figures given by Mr. Hills of a test made on February 27, 1903, are of great interest; not only is water gas made from the coke, but the actual yield of gas by distillation is increased.

Coal carbonised	31.07	tons
Total purified gas made	528,000	Cu. ft.
Total crude water gas made	144,000	" "
Make per ton, deducting water gas	12,359	" "
Make per ton, including water gas	16,993	" "
Water gas added, per cent.	37.5	
Water gas in mixture, per cent.	27.2	
Illuminating power unenriched	11.43	
Candle feet per ton	37,826	
Calories per cubic feet, gross	130.5	
Calories per cubic foot, nett	111.8	

One week's working gave

Coal carbonised	196	tons.
Total purified gas made	2,869,000	Cu. ft.
Total water gas added	459,000	" "
Make per ton, deducting water gas	12,295	" "
Make per ton, including water gas	14,635	" "
Water gas added, per cent.	19.05	" "
Water gas in mixture, per cent.	17.05	" "
Illuminating power (enriched	15.40	
Gallons of benzol added, per 1,000 cubic feet	0.81	

The cost for the blue water gas into holder is given as

	d.
Labour	0.68
Coke for generator	2.20
Fuel for boiler	.39
	3.27

and the make per ton of coke is about 60,000 cubic feet. Water gas is also being used satisfactorily in conjunction with the Peebles oil-gas process, the water gas and the oil gas being mixed in suitable proportions.

For certain purposes the non-luminosity may be a disadvantage, but this is so easily got over by carburisation that it is of little moment; but the high heating power of the gas in comparison with ordinary producer gas may in some cases necessitate changes in the details of the methods of using. The quantity of air required for combustion is of course very much larger than for ordinary producer gas, so that for combustion in regenerative plant the sizes of the regenerators and ports would have to be rearranged; but it does not seem that there should be any difficulty in using the gas for any purpose for which producer gas can be used.

Owing to the large percentage of carbon monoxide present, the gas is very poisonous; and as it is odourless, an escape cannot be readily detected, and in the early days of its use several accidents happened. In ordinary use as a fuel this is of little moment. It would be an objection for domestic use, but it is hardly likely to be used for lighting except in admixture with other gases, and if required an odour—as unpleasant as may be required—is easily imparted to it.

One objection often urged against water gas is that it cannot be made from the cheap coals usually used in gas producers of the ordinary type. At present this is of little moment, for coal gas is made on such a large scale that coke is obtainable at a reasonable price, but even if it were much dearer than it is now, water gas could still be made economically.

Very little has been done in the way of the recovery of by-products from gas producers, nor is it likely to be except in very large installations; and in the production of gas and coke by direct distillation the by-products can be recovered much more economically than from gas producers.

The gas is clean, free from tarry matters, and the sulphur will always be present as hydrogen sulphide, which is very easily removed.

On the whole, the process of Messrs. Dellwik and Fleischer has a great future. It seems to be the greatest advance in the production of fuel gas that has been made since the introduction of producer gas, and it well merits the attention of all users of fuel gas.

SPECIAL FEATURES IN THE DESIGN OF LOCOMOTIVE BOILERS AND FIREBOXES.

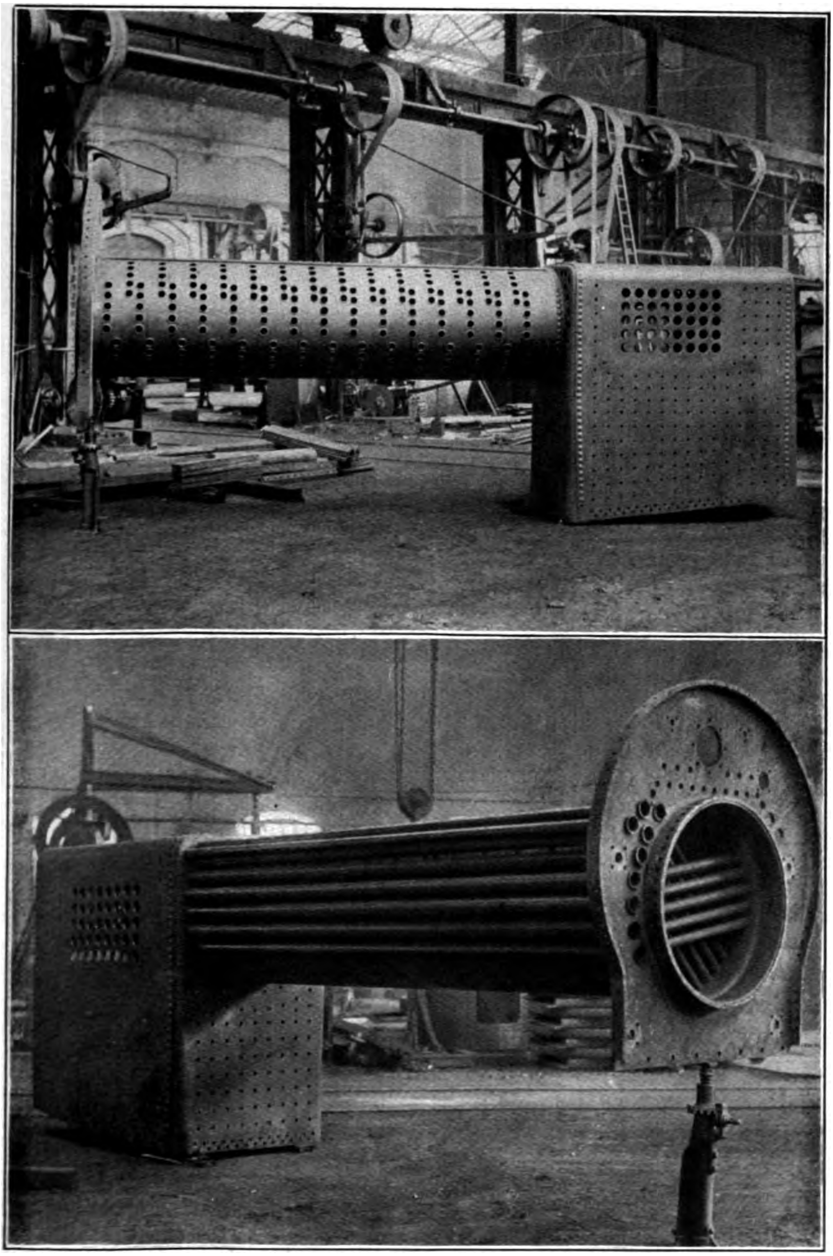
By Chas. S. Lake.

It was pointed out, in introducing Mr. Lake's first article to the readers of our October number, that locomotive practice embodied results of the utmost significance to steam engineering in all its branches, because the conditions of railway working had forced the locomotive designer to the limit of "intensified production" of steam power. His creations, therefore, represent the ultimate of the tendencies which are growing more and more apparent and the requirements which are growing more and more insistent in every stationary power plant. And this is most strikingly true of British practice because of the very close limitations imposed by the loading gauge of the British railways. In the present paper Mr. Lake concludes his review of the late work of the British engineers, and in a concluding article next month he will touch upon the most salient features of recent Continental and American practice.—THE EDITORS.

IN the early part of 1899 Mr. Dugald Drummond, the able locomotive superintendent of the London and South Western Railway, introduced a new pattern of firebox containing two groups of transverse water tubes, so arranged as to be easily accessible without having to dismantle the engine, or take it under the shear legs for the purpose of lifting the boiler.

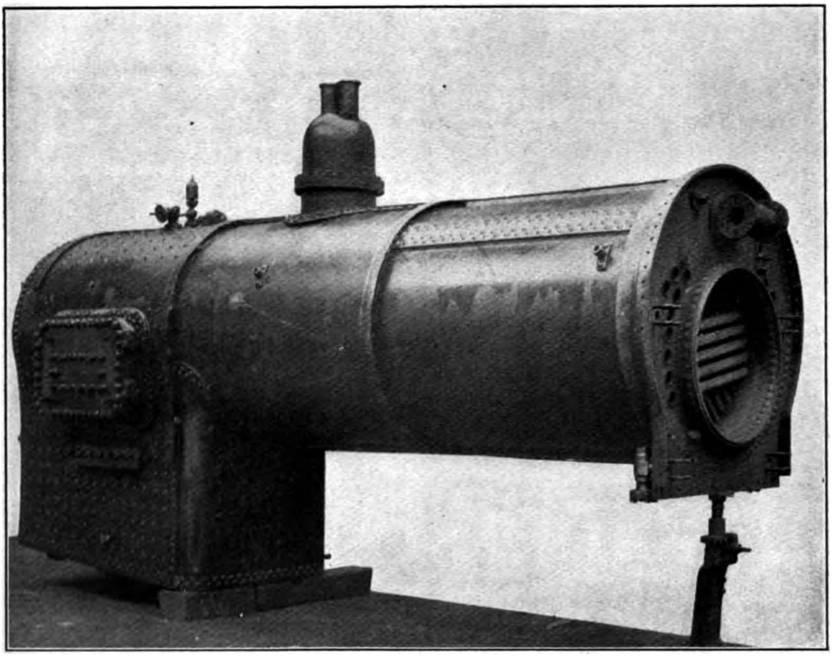
This is effected by means of providing two virtually rectangular apertures on either side of the outer firebox shell. A forged ring is rivetted on around each of these apertures and is faced to receive a door which, as will be seen in the figures, is held in position when open by two hinges attached to the aforesaid ring. A red-lead joint is provided between the face and the door and the two are pulled up tightly together by means of bolts and nuts placed all round the outside of the faced joint.

A neat wrought-iron cover, which can easily be detached in a few moments, conceals these doors, and thus constitutes the only difference (so far as outward appearance is concerned) between the engines which are fitted with the special fireboxes and those which are not. The water tubes, which are 2⅛ inches outside diameter, number 61 collectively, 25 being in the forward group and 36 in the other, the total heating surface obtained from them being 165 square feet. Those in the forward group are inclined in a downward direction towards the right-hand side of the engine and those in the rear group towards the



DRUMMOND'S WATER-TUBE BOILER, FIRST AND SECOND STAGES OF CONSTRUCTION.

left hand, (presuming that one is looking in the direction of the smokebox.) This is done with a view to promoting a good circulaton of the water. The inside firebox is of copper, and is stayed (in that portion occupied by the cross tubes) by means of long stay rods which pass through the tubes and are secured to the inspection doors by means of thimbles.



DRUMMOND'S WATER-TUBE BOILER, FINAL STAGE OF CONSTRUCTION.

The water tubes are of steel, solid drawn, expanded in the firebox plates and beaded over outside. The walls and crown of the firebox provide 148 square feet of heating surface which, added to the 165 contributed by the transverse tubes, brings the total for the firebox up to 313 square feet, a very material advance over the area usually obtained from this source.

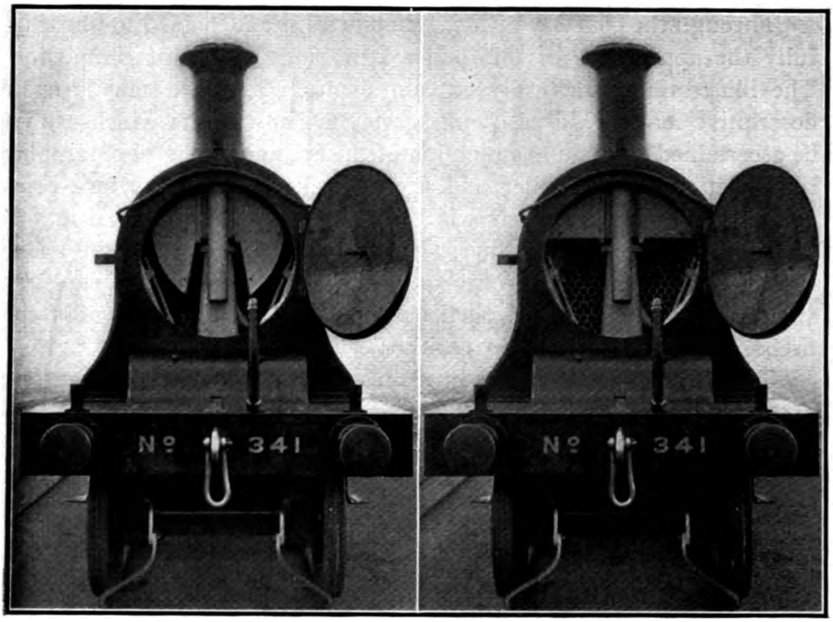
Having satisfied himself that the application of his invention to the fireboxes of locomotives resulted in their efficiency being increased, Mr. Drummond decided upon extending the sphere of his operations, and his next step was to design a water-tube boiler, in which as will be seen, he almost entirely dispenses with fire tubes, there being only 18 of these whilst no less than 215 water tubes are provided in the boiler and 40 more in the firebox.

Through the courtesy of Mr. Drummond, I am enabled to illustrate fully the appearance of this boiler at various stages of completion. The illustrations practically explain themselves, but a few lines of descriptive matter will assist in clearing up any points which cannot be ascertained from an examination of the accompanying photographic reproductions. The boiler and firebox, taken collectively, are comprised of four integral parts which may be briefly summarised as follows: (1) The cylindrical flue; (2) the inside firebox; (3) the boiler shell; and (4) the outside firebox. The upper picture on page 217 shows the two first-named portions ready, but for the absence of the firebox tubes, for placing in position.

The flue is 2 feet 9 inches in diameter and provides 86 square feet of area for heating purposes. The total heating surface from all sources is 736 square feet. The flue tubes (as can be plainly seen by referring to the pictures) are placed in a transverse position and at an angle of inclination, with the same object as in the case of the water-tube firebox previously described, viz; that of facilitating circulation of the water.

The present firebox contains 40 water tubes. These pass right through from one side of the outer shell to the other, connecting the intervening spaces between the inner and outer fireboxes. The longitudinal fire tubes are really of more value as stays than as contributors to the heating surface of the boiler. The greater volume of the furnace gases, as is only naturally to be supposed, passes through the flue and among the water tubes, only a small percentage of the products of combustion finding its way via the longitudinal tubes into the smokebox. The major proportion, having entered the flue at a very high temperature direct from the furnace, is thoroughly mixed withont being immediately cooled below combustion point. The flue water tubes, by virtue of the manner in which they are arranged, present an obstruction to anything like rapid transit on the part of the gases on their way from the furnace to the smokebox, and the effect of this impedimental influence is to bring about a more perfect combustion of these gases, with the result that by the time that they are finally delivered into the smokebox they have been divested of practically all their heating value, which has been transmitted to, and absorbed by, the water in such a thoroughly effective manner that the evaporative capacity of the boiler is considerably higher than is the case with the ordinary fire-tube pattern, although the dimensions in both cases are similar in all respects.

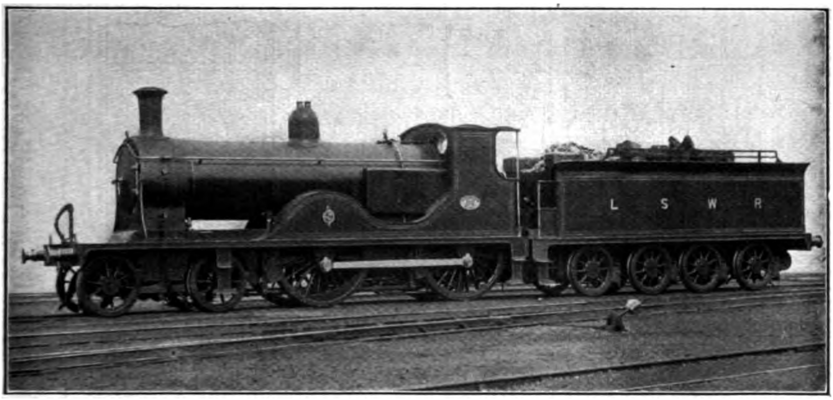
Mr. Drummond has given a great deal of attention to the subject of what is known in railway phraseology as "sparking." There are



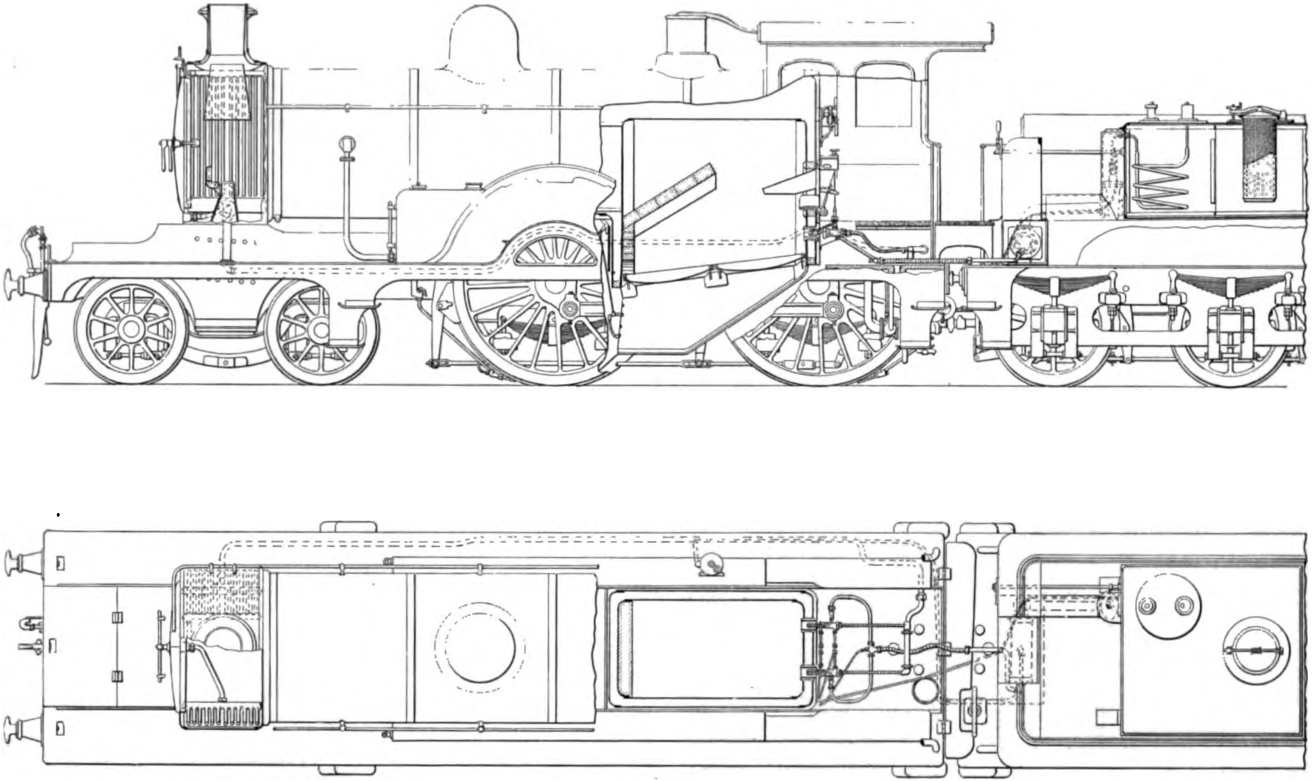
DRUMMOND'S SPARK PREVENTER AND FUEL ECONOMISER.
Left, running position; right, movable wings lifted for access to boiler tubes.

already a number of devices in use known as spark arresters, few of which however can be said to be really efficient for their purpose. It is no uncommon thing to read, in the course of evidence given in courts of law where claims for compensation for loss of property by fire, (alleged to be attributable to sparks thrown from the chimney of a locomotive) are the cause of litigation, that the offending engine was fitted with a "spark arrester" and the details of the appliance are, in the majority of instances, described in detail by the railway company's officials for the guidance of counsel and the presiding judge or magistrate. The point usually turns upon whether it can be proved that all reasonable precaution was taken to prevent the undue emission of red-hot cinders from the stack of the locomotive, and the verdict not unfrequently goes to the defendant company on the ground, that the apparatus fitted was "sufficient" to effect its purpose, and that the evidence was not sufficiently conclusive to prove that the origin of the destruction could be traced to lack of precaution on the part of the railway authorities, who, on their side, usually have something to say about "contributory negligence" in cases where the responsibility for the mischief has been brought home to them in an unmistakeable manner.

There is another aspect of the spark-throwing nuisance which concerns the railway companies alone, and that is the waste of fuel which is occasioned by wholesale sparking; and with the object of securing feedom from this objectionable feature Mr. Drummond has brought out a combined spark preventor and fuel economiser, which is illustrated by the pictures opposite. This device has given quite the best results of any arrangement which has been tried up to the present. The methods of construction and operation are as follows: Attached to the cap of the exhaust pipe by means of bolts and nuts are two fixed wings of fan-like shape, which form what is virtually a chamber. The exhaust blast pipe instead of leading direct from the smokebox passes into an extension which projects downwards from the chimney into the smokebox. At the sides of this extension two slotted holes are provided. These communicate with the chamber formed by the two fixed wings, to which are attached two moveable wings, which swivel on a pin (thereby enabling them to be folded up over the fixed wings) when it is required to gain access to the boiler tubes. The furnace gases, upon reaching the smokebox, pass first through the end of the moveable-wing chambers, next through the fixed-wing chambers and finally by way of the slotted holes referred to up the chimney in the usual manner. The nozzle of the blast pipe is above the level of the boiler shell and extends a few inches into the chimney proper. An equal draught through all the boiler tubes is obtained as a consequence of employing this arrangement, and the few hot cinders which find their way into the smokebox are deposited there and remain until it is convenient for them to be removed. Experiments with this apparatus have proved that an *average* saving of 5 pounds of coal per mile is effected by its



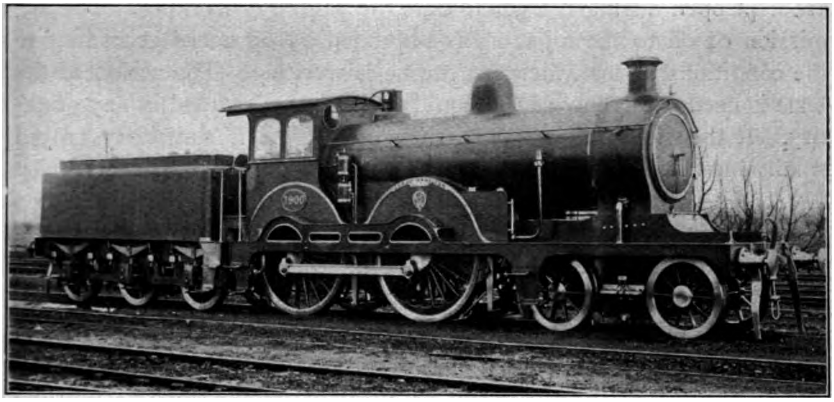
STANDARD 4-COUPLED EXPRESS ENGINE WITH WATER-TUBE FIREBOX AND SPARK PREVENTER, LONDON & SOUTH WESTERN RAILWAY.



HOLDEN'S LIQUID-FUEL. APPARATUS, AS FITTED TO EXPRESS PASSENGER ENGINES, GREAT EASTERN RAILWAY.

use—a very considerable item in the expenses of a large railway company.

The Great Eastern Railway Company have a large number of locomotives in operation which are fitted with the necessary apparatus for burning liquid fuel. Mr. James Holden, the locomotive superintendent of the line in question, is the patentee of the oil-fuel system which bears his name.



THE CLAUD HAMILTON, LIQUID-FUEL-BURNING EXPRESS LOCOMOTIVE, J. HOLDEN'S SYSTEM.

The principle of this system can be easily understood by reference to the drawings (kindly supplied by Mr. Holden) which accompany the following description. The engine shown is, it should be stated, one of the large bogie express locomotives known as the "Claud Hamilton" or exhibition type—in fact the drawing, as will be seen, represents the "Claud Hamilton" itself, the pioneer of the type and one of the few purely British locomotives exhibited at the Paris Expositon of 1900.

The liquid fuel is contained in a tank of 500-gallons capacity which is carried upon the tender. Two pipes connect this tank with a couple of injectors which are placed in specially prepared orifices in the firebox plates 12 inches above the bars. After a considerable amount of experimenting it has been found that at this height the best results can be obtained.

The fire bars are of the ordinary pattern, as indeed is the entire construction of the firebox. A layer of broken fire bricks is spread upon the bars to a depth of 9 inches at the back, under the burners, 4 inches in the centre, and 6 inches in front. A small coal fire is made up on the centre of the bars and is kept alive without having recourse to the liquid fuel until it is required to start the train. Then the injectors are brought into use and deliver the oil in the form of spray upon the coal fire, the result being to produce, in a very short space of time, an intense heat which can be easily maintained by means of further spray injections as occasion demands.

Steam is employed as the propelling agent in the spraying operation. The steam mingles with the oil and sets up a strong induced current of air though the central air tubes of the injectors. The steam cocks are kept open during the whole time the engine is working. The admission of oil to the injectors is regulated by oil cocks according to the conditions under which the engine is working. The action of the blast is needed to allow of the liquid fuel being consumed in any quantity. It therefore follows that when the engine is stationary only a small amount can be used.

A bell-shaped orifice is provided at the bottom of the smokebox, and through this a supply of air enters, and, after passing through a number of small pipes running round the inside of the smokebox, is conveyed by means of a larger pipe to the injectors. By this means the temperature of the air is raised, to such an extent that by the time it reaches the injectors it is about 400 degrees F. The liquid fuel is delivered to the injectors at 200 and the steam at 250 degrees F. The air-inducing rings are of a modified form in the later engines of Mr. Holden's design. As a result of these modifications a greater amount of efficiency in atomising and distributing the oil fuel has been obtained.

If any difficulty should be met with in keeping up a sufficient head of steam when the engine is on heavy duty, or is not, for any reason, steaming well, a thin coal fire is sometimes used over the broken bricks, but it is only on very rare occasions that this expedient is resorted to.

The four principal ingredients of which the liquid fuel is composed are oil, coal-gas tars, creosote oils and petroleum residues. The value, as a heating agent, of any of the component substances mentioned, is nearly twice that of coal, provided of course that they be of good quality. The higher calorific value of the fuel, taken in conjunction with its great portability, form a strong combination of points in its favour.

The extra expense entailed in fitting the apparatus must of course be set against the many advantages which accrue from its use, but even then a substantial margin of gain is assured in the long run.

The first really successful engine adapted to the use of liquid fuel was the "Petrolea" built in 1890. During the whole of the period represented by the intervening years Mr. Holden has been indefatigable in improving his system, by means of experiments and exhaustive observations, and the net result of his labours is to be seen in the highly proficient stage to which he has brought this important branch of engineering development, for which he is justly considered as one of the most able authorities upon the subject of steam generation.

Before bringing that section of this article which deals with British practice to a conclusion, reference must be made to the highly interesting and important experiments which are being carried out by Mr. H. A. Hoy upon the Lancashire and Yorkshire Railway, with a locomotive fitted with a cylindrical corrugated firebox. The idea of adapting this pattern of firebox to locomotives is not by any means a new one, neither is it confined to Great Britain. In America cylindrical fireboxes are being used with good results, but Mr. Hoy is the first engineer to introduce them upon any of the English main lines. The locomotive selected for testing the value of this latest departure from regular practice is an eight-coupled mineral engine built at the company's works at Horwich in 1902.

The principal advantage claimed for fireboxes constructed upon this plan are briefly as follows

1.—A free circulating area

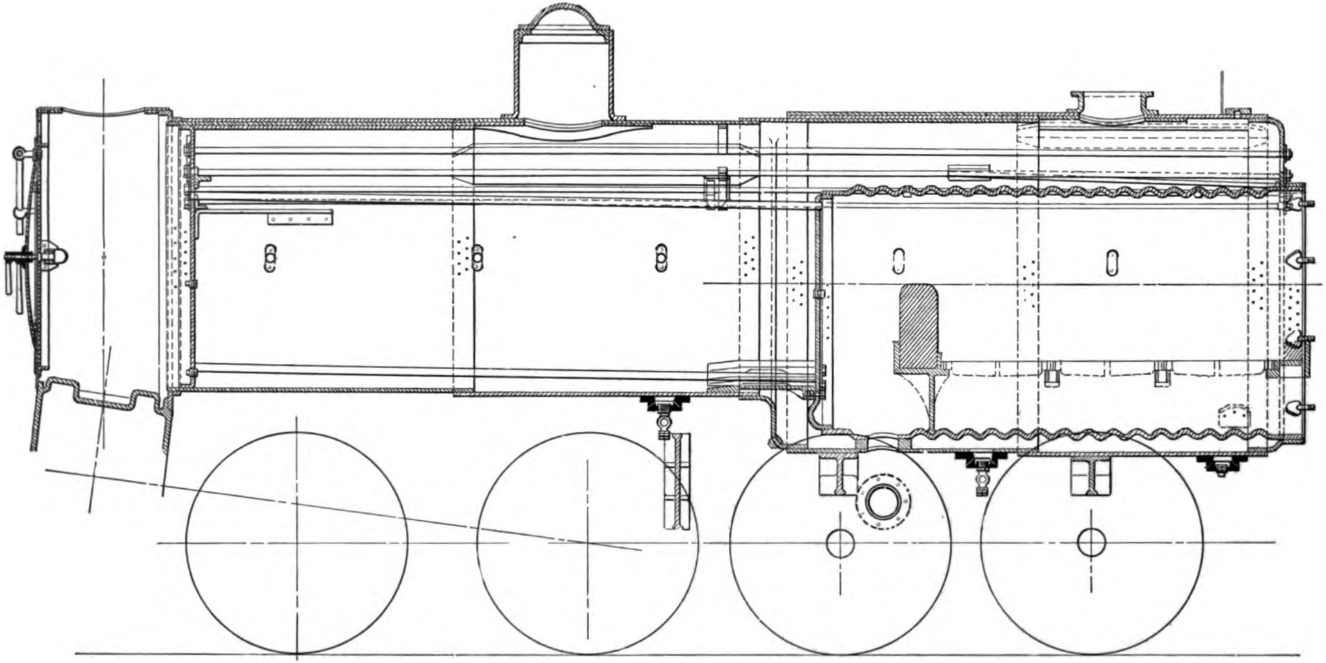
2.—General simplification of construction

3.—Avoidance of the necessity for using screwed stays and a copper firebox.

There are also other points in favour of the innovation which could be urged on theoretical grounds, but it remains to be seen whether any or all of these will be realised under actual working conditions.

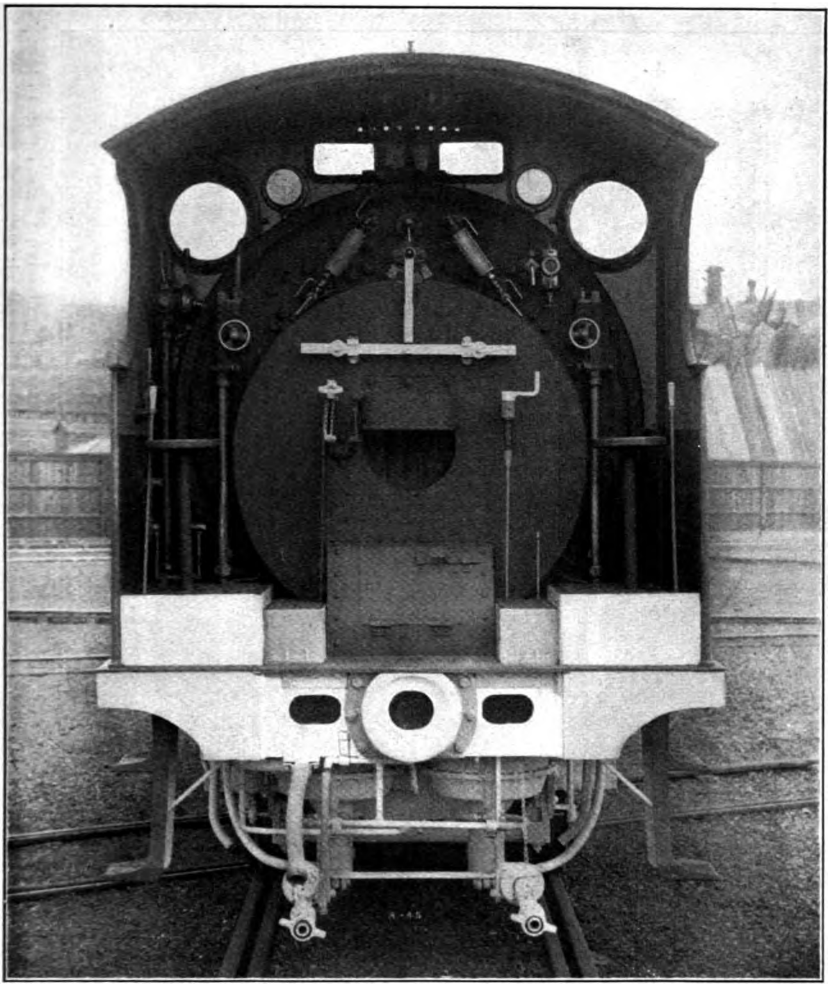
In the particular engine under notice the barrel of the boiler is 12 feet 3½ inches long and has the very large diameter of 5 feet 4 inches inside its smallest ring. The shell of the firebox is 6 feet 9¾ inches diameter inside, and the firebox itself takes the form of a cylindrical corrugated flue, 9 feet 11½ inches in length and 5 feet 1½ inches diameter outside. The corrugations are 1½ inches in depth, the ribs having their centres spaced at 6 inches apart. The material used is steel, ¾ inch in thickness.

The crown of the firebox shell rests on the top of the boiler barrel owing to its centre line being 5¼ inches below that of the barrel. The centre line of the corrugated flue is lower again by 7⅛ inches than that of the firebox shell. Further particulars can be gathered from the drawings. The extreme length of the firebox would lead one to suppose that difficulty would be experienced in properly firing it, but the men who are employed to run the engine distinctly state that such is not the case.



LOCOMOTIVE WITH CORRUGATED FIREBOX, LANCASHIRE & YORKSHIRE RAILWAY.

By courtesy of *The Engineer*.

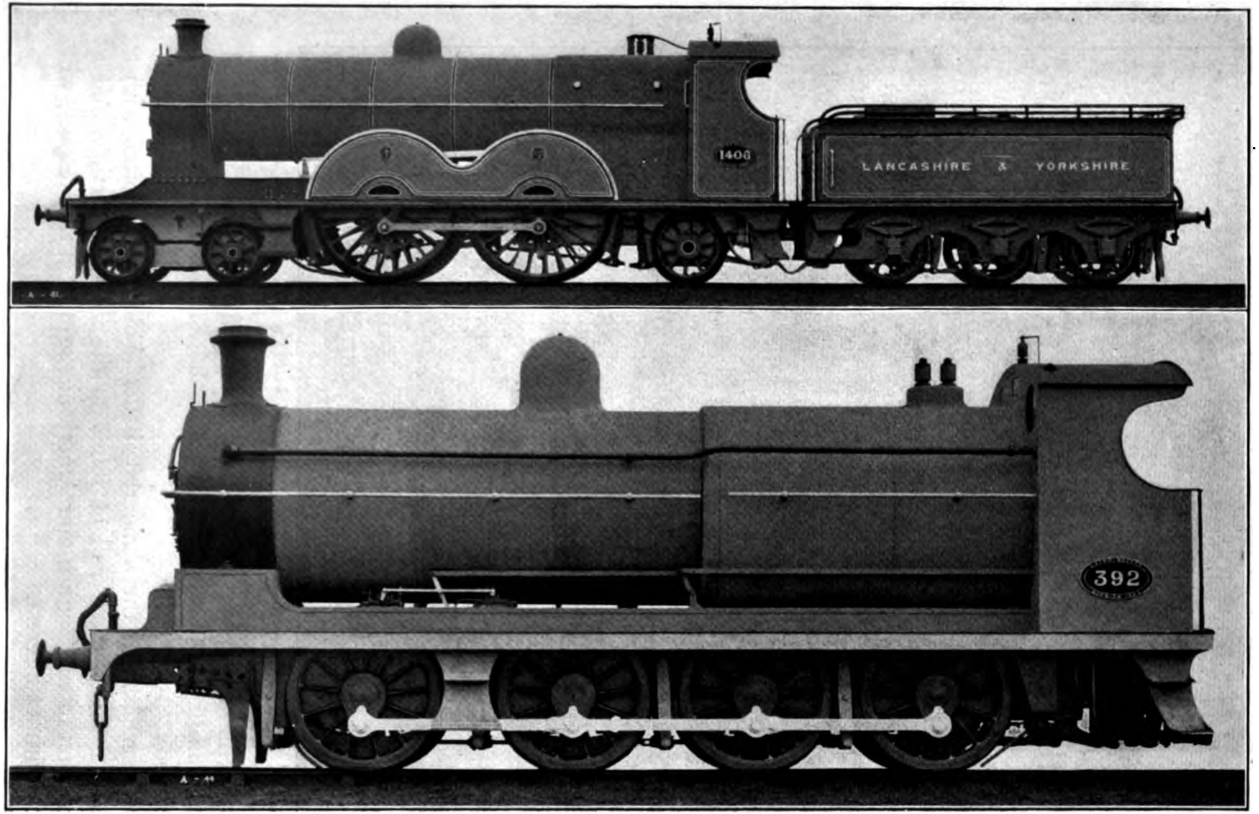


FOOTPLATE END, LANCASHIRE & YORKSHIRE 8-COUPLED ENGINE WITH CORRUGATED FIREBOX.

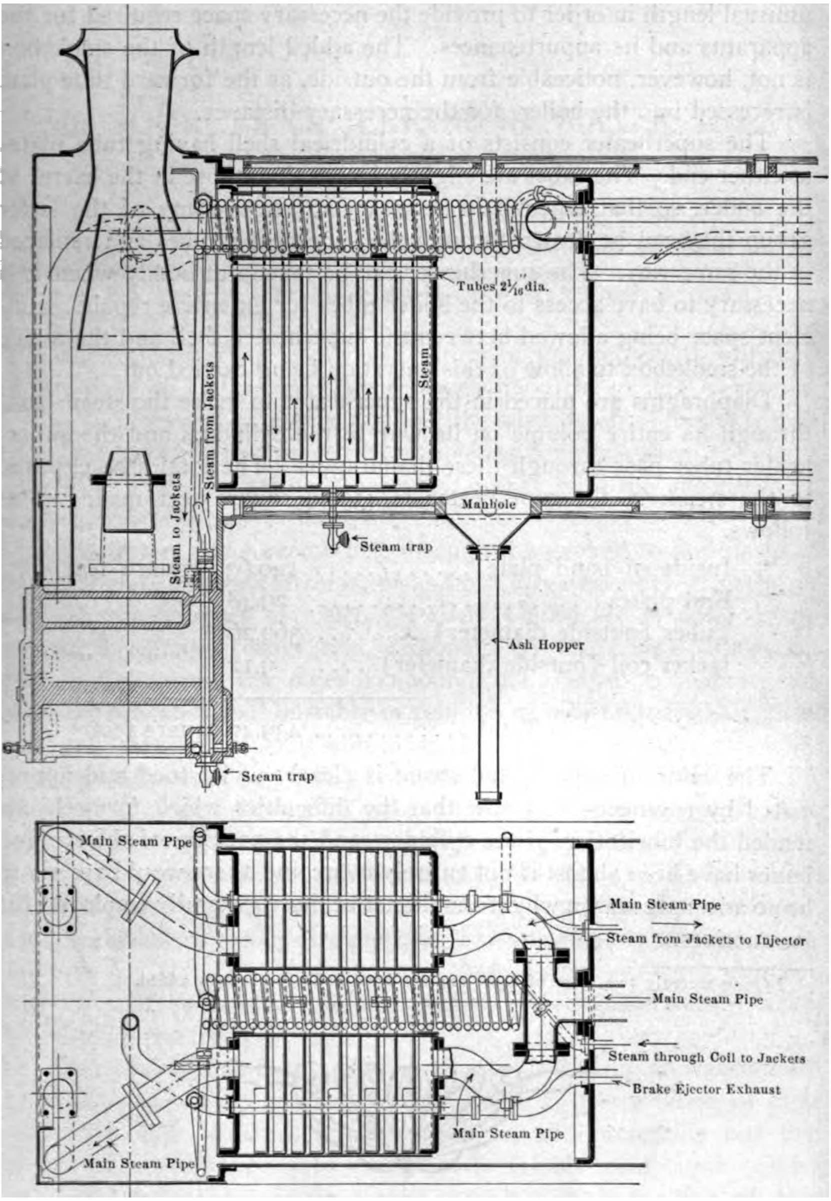
They further assert that it is a much easier matter to keep up a good head of steam with this engine than with those fitted with the ordinary pattern box.

A description of the Vanderbilt boiler, which is also fitted with a cylindrical flue firebox, will be found in the following article, and a comparison of the English and American engines, in this respect, will not be without interest.

One of the large express engines of the "1400" class designed by Mr. Aspinall in 1900 for the Lancashire and Yorkshire Railway is



Above is the Lancashire & Yorkshire 10-wheeled Express Engine; weight 58 tons 15 cwt., cylinders 19 by 26, drivers 7 ft. 3 in., 1877 ft. tube surface, 175.8 ft. firebox, 26.05 ft. grate. Below is the 8-wheels coupled goods engine of the same road; weight 57 tons 18 cwt., cylinders 20 by 26, 1882 ft. tube surface, 135 ft. firebox, 33 ft. grate.



SUPERHEATER FITTED TO LANCASHIRE & YORKSHIRE 10-WHEELED EXPRESS LOCOMOTIVE.

fitted with a superheater.* This is placed in the smokebox, which is of unusual length in order to provide the necessary space required for the apparatus and its appurtenances. The added length of the smokebox is not, however, noticeable from the outside, as the forward tube plate is recessed into the boiler, for the necessary distance.

The superheater consists of a cylindrical shell having tube plates at either end. The tubes are slightly larger than those in the barrel of the boiler, so that when it is necessary to remove any of the latter group they can be drawn through the superheater tubes and replaced in the same way. The superheater can be taken out bodily when it is necessary to have access to the boiler tubes for extensive repairs, sufficient space being allowed between the superheater shell and the inside of the smokebox to allow of this operation being carried out.

Diaphragms are placed in the superheater to make the steam pass through its entire volume on its way to the cylinders and the superheater tubes pass through these diaphragms. The total area exposed to the steam in the superheater is 439.49 square feet made up as follows.

Inside of band plate	40.63	square feet
End plates	29.48	" "
Tubes (outside diameter)	360.26	" "
Jacket coil (outside diameter)	9.12	" "
Total	439.49	square feet

The value of superheated steam is clearly understood and appreciated by engineers, and now that the difficulties which formerly attended the lubrication of the cylinders and the packing of the stuffing boxes have been almost if not entirely overcome, there would appear to be no adequate reason why it should not be more generally employed for locomotives.

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* Quite recently two more of these engines have had superheaters added.

SOME SOURCES OF ERROR IN WATER TREATMENT.

By H. Spencer Flynt.

Mr. Flynt's admirably clear explanation of the methods of water purification and the difficulties and mistakes to be avoided will be of great service both to those who are using and those who are introducing sound systems of water softening for industrial or domestic purposes.—The Editors.

BEFORE entering into consideration of this subject it will perhaps be not out of place to touch upon the general causes of hardness in natural waters and the most practical methods that have been adopted to remove this trouble, as doubtless there are many interested in the matter who are not familiar with the chemistry of water purification.

Rain water, while percolating through the ground to find its level in the surface or deep streams, picks up a large quantity of carbonic acid, by the presence of which the chalk (carbonate of lime), magnesian limestone, (chalk and carbonate of magnesia), ironstone, soda, potash, and a few other compounds are enabled to dissolve, and are held delicately and unstably in solution as bicarbonates. To illustrate this state of combination in formulae let us take chalk for example. This is calcium oxide (CaO) combined with carbon dioxide (CO_2) and is the monocarbonate of lime, almost insoluble in water. But let it come in contact with a water highly charged with carbon dioxide, a water that is in reality a solution of carbonic acid (H_2CO_3), and the chalk is dissolved, and will remain dissolved so long as the carbonic acid is present in sufficient quantity. The combination now takes the formula $CaO.\ (CO_2)_2 + CO_2$, or calcium oxide combined with two molecules of carbon dioxide and held in this delicate state of combination by the free CO_2.

Now the fundamental operation in the softening of waters hard from this cause is to remove the excess CO_2 by the addition of some substance with which it readily combines, and preferably one that forms an insoluble, or only very slightly soluble, compound. Quick lime (calcium oxide), when carefully dealt with, is the best of these on account of its cheapness and splendid efficiency. The quantity of excess CO_2 in the hard water is determined by analysis, and from the result the required amount of calcium oxide is calculated to completely satisfy this in the process of forming chalk. The lime is added to the water in the form of milk of lime of known strength, and what might be termed the beautiful part of the reaction is the double transformation that takes place. The newly added milk of lime not only becomes insoluble chalk by combination with the carbon dioxide, but reduces the bicarbonates of lime and magnesia to the insoluble monocarbonates, and all three fall together in the form of a heavy and rapidly clearing precipitate. The reaction with regard to iron differs from the two former in this respect, that the bicarbonate of iron when robbed of its carbon dioxide is reduced for a moment to ferrous oxide, which, in turn, goes rapidly through the process of combining with more oxygen to form ferric oxide and falls with the chalk and magnesium carbonates in the form of red rust, the supernatant water remaining perfectly clear and soft. The potash and soda, of course, remain dissolved, but are not in any way harmful if present in only small quantities.

Superficially considered, the softening of large supplies of hard water for various purposes—steam raising, laundry work, domestic use, etc.—would appear to be one of the simplest and safest processes in chemical engineering—a process offering special success to the application of automatic apparatus. But this is true only under certain conditions, and it is the purpose here to point out where those conditions often fail. I do not wish to criticise or cast reflexions upon any of the numerous softening plants now upon the market. Many of them are ingenious in their simplicity and most are efficient when properly managed. But no process can be automatic and remain continuously efficient when some of the conditions are inconstant quantities. The reagents employed are inconstant in their proportion of real active substance, especially lime; the man who does not know how to weigh accurately or believes in the virtues of the "bit extra for luck" is perhaps the most dangerous of the inconstant quantities; the water itself sometimes varies a little with the atmospheric temperature, and, if deep well water, it alters considerably when drawn to the surface and exposed for any length of time. Under varying conditions of this kind, sometimes coupled to gross carelessness on the part of a man in charge who knows nothing of the theory of the undertaking, it is not surprising that automatic water-softening plants of really excellent design often fail to do the guaranteed duty and are condemned.

After analysis of a given sample of water, the manufacturer of a purifying plant guarantees to treat the supply from which it was taken in such a manner as to bring it down to some stated low degree of hardness, and so long as the value of the chemicals used, in actual reacting substance, is known and the plant kept in good condition—i. e., all leading and discharge pipes free from choking by precipitated matter or incrusted milk of lime; kept, in short, of sufficient area to maintain a given flow—this low degree of hardness may be confidently ensured.

It is after the manufacturer has finished supervising the plant and explaining away perplexing circumstances that troubles may arise. In the hands of the ignorant there are two sources from which difficulties may occur with a water-softening plant, *under-treatment* and *over-treatment.* The latter, though perhaps transforming a rusty or cloudy water to a clear and sparkling one, to all outward appearances pure, may make it considerably worse, especially for boiler and laundry purposes, than it was originally. Even if the man in charge is instructed in the determination of the extent of over-treatment by use of phenolphthalein and a standard acid, the only thing he can do is to under-treat a subsequent volume of water in such a manner that neutrality will result when the two volumes are mixed. But this course must necessarily bring about secondary precipitation in the reservoir or pipes, and if resorted to at all frequently will cause the water to be more or less opaque owing to fine particles in suspension that have come into being *beyond the filter,* and therefore cannot be removed without a great waste of time in settlement and careful decantation.

Where caustic soda alone is used as the reagent, the danger of error from either of these causes is considerably reduced, for the reason that caustic soda containing a constant and guaranteed percentage of sodium oxide is readily to be obtained in the open market. But apart from the fact that this is about twice as expensive as the lime or lime and soda ash methods, it is applicable to industrial purposes only and cannot be employed in the treatment of towns' water or private drinking water supplies. Caustic soda, however, is a compound that is not to be trusted implicitly unless it is carefully dealt with. If the supply is kept on stock it should be kept water-tight, air-tight, and free from carbonic acid gas. It absorbs water, even from the atmosphere, with wonderful rapidity, altering its weight accordingly, and if in contact with CO_2 gas is changed at once to carbonate of soda and is no longer capable of softening waters that are hard (as most waters are) by reason of their dissolved CO_2 and bicarbonates of lime and magnesia. I have known many mistakes of this kind to occur through the ignorance—not blameworthy ignorance, it is true, since nobody expects the labourer or ordinary mechanic to be familiar with application of chemical laws—of men put in charge of automatic softening plants. But the fact that disturbing influences are liable to arise from so numerous and varied causes is sufficient to prove that water purification is not the simple undertaking it is generally supposed to be, and that it cannot be made a complete success automatically unless all the conditions are constantly favourable.

When treating with quick lime, either alone or in conjunction with soda ash, the chances of erratic results are much greater, principally because lime is habitually taken less care of than caustic soda. From the time it leaves the kiln it is exposed and at once starts to become hydrated by atmospheric moisture, or "air-slaked," and this process is immediately followed up by combination with carbonic acid gas from the air or any other source with which the lime comes in contact, till, given the right conditions as to time and environment, the whole of the quick lime, or calcium oxide, is resolved back again into chalk, or calcium carbonate, which is useless for water softening. It is highly improbable that the whole, or even half, of a quantity of lime would have become chalk before delivery and use at a water-softening plant; but to whatever extent the process of transformation has gone on, to that extent is the total percentage of calcium oxide reduced and the lime weakened. The cost of the deterioration in itself is inconsiderable. It is the trouble caused in the subsequent treatment of water with a reagent of uncertain and variable strength that becomes a matter of serious concern. In my experience lime supplied as 97.5 per cent. calcium oxide was on more than one occasion found to be 25 per cent. below that strength after it had been in stock two days, and kept during that time in a metal bin with a tight fitting lid. On the first occasion the man in charge of the softening plant, on finding that the water was cloudy when emerging from the settling chamber, concluded the prescribed quantity of lime used was not enough and went on adding more till the water was in reality largely over-treated, but still, to his perplexity, remained cloudy. This cloudiness was due to the finely divided chalk contained in the quick lime remaining in suspension after the iron oxide and reduced bicarbonate of
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cope with the trouble with the confidence of special knowledge, should it ever occur again. But it is not every man who has the opportunity of acquiring such special information when it is most needed. And therefore unless water-softening plants are under scientific supervision, either continuously or at frequent and regular periods, some inefficiency is unavoidable. In the nature of things it must be so when one considers the relentless precision of automatic action operating with other conditions that vary.

Pure soda ash (or partially refined carbonate of soda) may be obtained at a little under a penny per pound in quantity, of sufficient purity and regularity of strength to be quite reliable for the purpose of water treatment. But soda ash is applicable as a softener only to waters that are hard by reason of the sulphates and silicates they hold in solution. In this case the lime and magnesia give up to the soda the sulphuric and silicic acids with which they are combined, and take from it its carbonic acid, forming insoluble carbonates of lime and magnesia, which are precipitated, leaving in solution the harmless compounds of soda with sulphur and silica. But were soda ash added to a water hardened by the commoner causes, bicarbonates with free carbonic acid dissolved, no reaction would take place, and matters might be considered worse than before, owing to the addition of more unnecessary solids in solution. It can be used only in conjunction with lime, and then only in the purification of waters containing silicates or sulphates or both. Therefore, though it is less likely to prove a false friend than quick lime or caustic soda, its application is limited and it cannot be expected to take their place. The condition the most important in other chemical processes applies equally to water purification, and should be realised by all who own or have charge of such undertakings—that is, *care*, and a sufficient knowledge of what is taking place to render one capable of helping the apparatus to do its best work.

ORE QUARRYING IN THE BOUNDARY DISTRICT OF BRITISH COLUMBIA.

By E. Jacobs.

The interest of Mr. Jacobs' article lies not only in its description of novel mining methods, adapted to unusual conditions, but in its suggestion of a wide field for the profitable employment of mining talent and mining machinery. The position of the district makes it of international importance.—The Editors.

ONE of the most striking features of mining in the Boundary District of British Columbia is the method adopted in dealing with the immense bodies of copper ore occurring in several parts of the district. The ore output of copper is now a leading factor in the production in Canada, the Boundary having last year produced 14,955,582 pounds of copper out of a total for British Columbia of 29,636,057 pounds, and for the whole Dominion of 39,154,733 pounds.

The Boundary comprises the south-eastern portion of what is officially known as the Yale District of British Columbia. It extends, approximately, from the summit of the divide between the Columbia River and Christina Lake, on the east, to that between the Okanagan and Kettle River valleys, on the west, and includes the greater part of the Kettle River (now Greenwood) and Grand Forks mining divisions. It is generally mountainous, though few of its mountains exceed 5,000 feet in height, and is intersected by four principal longitudinal valleys—those of Christina Lake, North Fork of Kettle River, Boundary Creek, and the main Kettle River, respectively. East and west its width is from 50 to 60 miles, whilst it covers 40 to 50 miles of country north from the international boundary line between British Columbia and the adjoining State of Washington.

It is about eighteen years since pioneer prospectors first staked copper claims in the district, only to abandon them afterwards owing to their inaccessiblity for practical purposes, and the unlikelihood that waggon roads or railways would be constructed so as to afford transportation facilities within a reasonable time. Later—in 1891—the Mother Lode, Old Ironsides, and Knob Hill claims, among many others, were located, but even then there was not a waggon road within miles of what have since been developed into the largest copper mines in Canada. By the summer of 1896, however, some little advance had been made in the direction of obtaining road communication, and in the autumn of that year a New York syndicate commenced to open up the Mother Lode, now a big mine owned by the British Columbia Copper Company, Ltd., of New York. The following autumn mining was begun on the Old Ironsides and Knob Hill, now part of a group of ten adjoining claims the property of the Granby Consolidated Mining, Smelting, & Power Company, Ltd., and thenceforward development work was steadily prosecuted. By the close of 1899 the Canadian Pacific Railway Company had built the Columbia & Western Railway into the district from the Columbia River, and this gave railway connection with the outer world. In August of 1900 the Granby Company's smelter at Grand Forks, B. C., commenced operations, and in February of 1901 the B. C. Copper Co. started smelting at its works at Greenwood. June of 1902 saw a third district smelter at work, this one being owned by the Montreal & Boston Copper Company, Ltd., and situate at Boundary Falls, near Greenwood. Up to the end of June of the current year these three smelters had together treated 1,164,621 tons of ore, in the following proportions: Granby Co. 769,485 tons, B. C. Copper Co. 326,223 tons, and Montreal & Boston Copper Co. 68,913 tons. Recent enlargements of all these works have so increased their treatment-capacity that by the close of this year the aggregate tonnage of ore treated will probably have exceeded 1,500,000 tons.

But it is not aggregate tonnage that has attracted wide-spread and interested attention to the district, for as yet this is small in comparison with the output of the older copper-mining districts of the United States. Rather is it the enormous size of some of the ore bodies, the low cost of mining practicable by open-cut or quarrying methods, and the favourable nature of the ores to rapid and economical smelting, which characteristics are remarkable to such a degree as to arouse incredulity among many not familiar with the unusual conditions prevailing here. The approximate dimensions of the respective ore bodies are stated in the descriptions that follow of the several mines at which quarrying methods have been adopted. With such large deposits of ore to work by these economical means, it will be readily understood that the cost of production in adequately equipped mines is kept very low. The cost of quarrying, inclusive of crushing the ore, and all office and administration expenses, is between 85 and 95 cents per ton. Of this crushing costs about 5 cents and administration expense about 10 cents per ton. Under favourable conditions even this low cost can be reduced. Further, the occurrence in the larger mines of immense bodies of ore of varying character—silicious, calcareous, and ferruginous—fairly uniform in value and generally free from bismuth, arsenic, antimony, and other constituents objectionable from a smelting standpoint—makes it practicable to smelt quickly and without the use of barren fluxing material, and to produce directly a 45 to 50 per cent copper matte at a much lower treatment cost than is usual elsewhere.

During the field-work seasons of the three years 1900-1902 the Boundary District had the particular attention of a Canadian Geological Survey party, so that much valuable information relative to its topography and geology has been obtained and placed on record. Mr. R. W. Brock, geologist in charge of that party, describes the geological structure of the district as complex and diversified.

> "Eruptive rocks (including granites, greenstones, lavas and associated tuffs, and various intrusive dykes,) have the widest distribution. More or less altered sedimentary rocks (limestones, argillites, and quartzites,) together with more highly altered metamorphosed rocks, including serpentine, are met with in all parts of the district, but do not, as a rule, have large dimensions in any one place, being usually nothing more than inclusions of older formations, caught up in the intrusive rocks. The oldest rocks recognised in the district are the sedimentary and crystalline rocks."

Regarding the mineralogy of the district Mr. Brock remarks in part:

> "The ore bodies may for convenience be roughly divided into three classes: (1) The large low-grade copper-bearing sulphide deposits; (2) the oxidised copper veins, and (3) the small gold and silver-bearing quartz veins. Undoubtedly the most striking characteristic of the deposits of the first class is their enormous size. In structure these deposits belong to the composite-vein type, formed by mineralising solutions traversing the country rock, principally along fissures or zones of fissures in which they deposit the economic minerals, and from which they replace with their mineral contents, particle by particle, sometimes only partially and sometimes completely, the original material of the country rock. On the outskirts of the ore body this substitution may be seen in all stages of development, the individual constituents of the country rock being one by one replaced. According to the most prominent mineral content, this class of deposits may be sub-divided into a pyritic type, in which pyrrhotite and chalcopyrite, with some pyrite, are the chief minerals. Excepting that the pyrrhotite of the one is represented by the magnetite in the other, these two types appear to be identical. Both replace the constituents of the country rock in the same way; both are accompanied by the same accessory and gangue minerals, and the country rock shows the same alteration in both cases. Rarely do both pyrrhotite and magnetite occur in the same deposit. The values in the ores are principally in copper and gold, sometimes with accessory silver.

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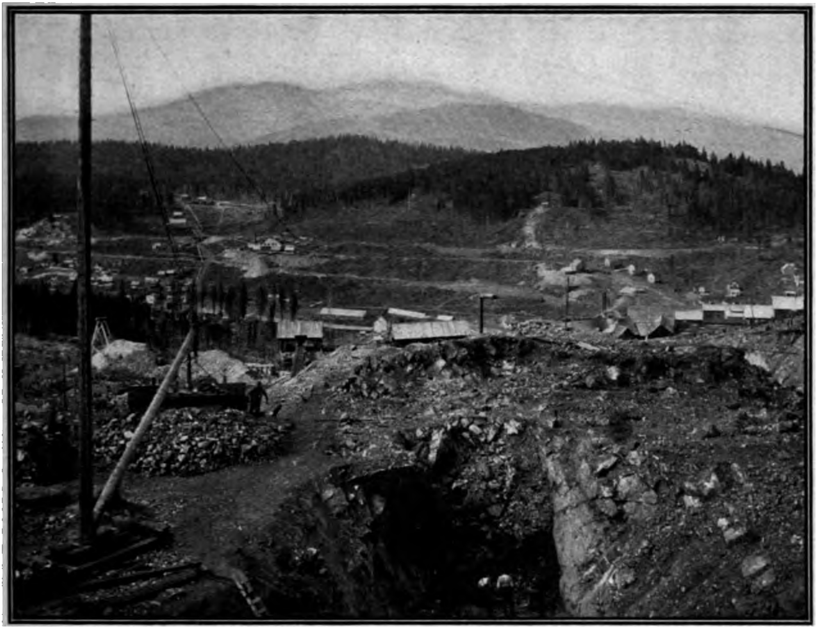
a large quantity of rock, holes are "sprung" or "chambered," by first firing in the bottom of them a little explosive until a "chamber" has been made large enough to take sufficient powder or dynamite to do the work intended. The quantity of explosive used varies according to the conditions, the nature of ground, depth of holes, nearness to buildings liable to damage, etc., determining whether the charges shall be large or small. Where it is intended to break down large quantities of rock a round of holes will average 12 feet in depth, and the charge used will range up to half a case (50 sticks) of dynamite, or a proportionate quantity of black powder if that be used. Further blasting is necessary to break up the large rocks, but, unless these are very big, drilling is not required, the custom being to "bull-doze" them by placing high per cent. dynamite on the top of them and covering it with loose earth before firing.

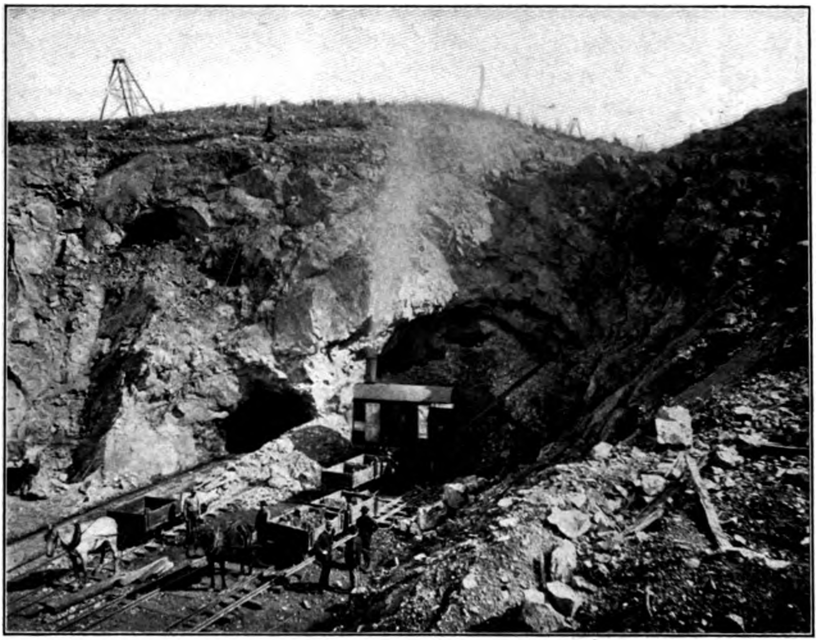
The Granby Co.'s Mines.—The largest ore deposit yet discovered in the Boundary District is that occurring on the Granby Company's properties. The full dimensions of this are as yet unknown. Some time since the provincial mineralogist, after visiting the property, described this ore body as a "huge mineralised zone of fine-grained, eruptive rock, highly altered and occurring near a contact with limestone. Through this rock is disseminated yellow copper sulphides, magnetite, and magnetic iron pyrites, with small stringers of calcite, while, occasionally, the iron sulphides and oxides become massive." Dr. A. R. Ledoux, of New York, who visited the Boundary District about two years ago, was there informed that this ore contains on an average 38 per cent. of silica, 16 per cent. of oxide of iron, 15 per cent. of lime, and 4½. per cent. of sulphur, there being but little change between the surface and deeper ores so far as their chief constituents are concerned.

The earlier development done on the property consisted of the customary exploratory work by means of shaft-sinking on the Old Ironsides and Victoria claims and tunnelling on the Knob Hill, with cross cuts and drifts from these main workings. The No. 2 shaft, on the Victoria, was sunk to a depth of 400 feet and levels were run at 200 and 300 feet depth. It is a literal fact that on the former level two sections of ore, each fully an acre in area, were blocked out by having cross cuts or drifts so run as to show the ore on all sides of each block. One section of like area was similarly blocked out in the Knob Hill, on which claim a tunnel, known as No. 1, was started at the extreme northern boundary of the claim and driven diagonally across it a distance of 634 feet, until it reached the east side line, the



GRANBY MINES, PHOENIX, B. C.
Tramway Pits, Looking North to the Ore Crusher.

direction of which was then followed, the tunnel eventually entering the Grey Eagle claim. A vertical raise to the surface, started at 366 feet in from the mouth of the tunnel, was in solid ore its full height of 135 feet. Another connection between tunnel and surface was made at about 500 feet farther in. Cross cuts east and west from the main tunnel, started at the foot of the first raise, but which did not reach barren rock, proved the ore body to be there at least 200 feet in width at right angles to its general trend. Finding that the deposit of ore was of enormous dimensions, and that conditions were favourable to a more economical handling of it, ordinary methods of mining were departed from and ore quarrying here had its inception in the Boundary District. Eventually the raises were enlarged, more similar connections were made, and the ore was broken from the surface downwards, until latterly the top quarry, now known as No. 1 pit, assumed large proportions, being about 100 feet in width and having a face in ore about 300 feet in depth, including the raise from the level of No. 1 tunnel, and with the ore rising with the hill so that by the time the highest point of the outcrop shall be reached there will be a face of at least 350 feet. No. 2 pit is at a level between No. 1 pit and



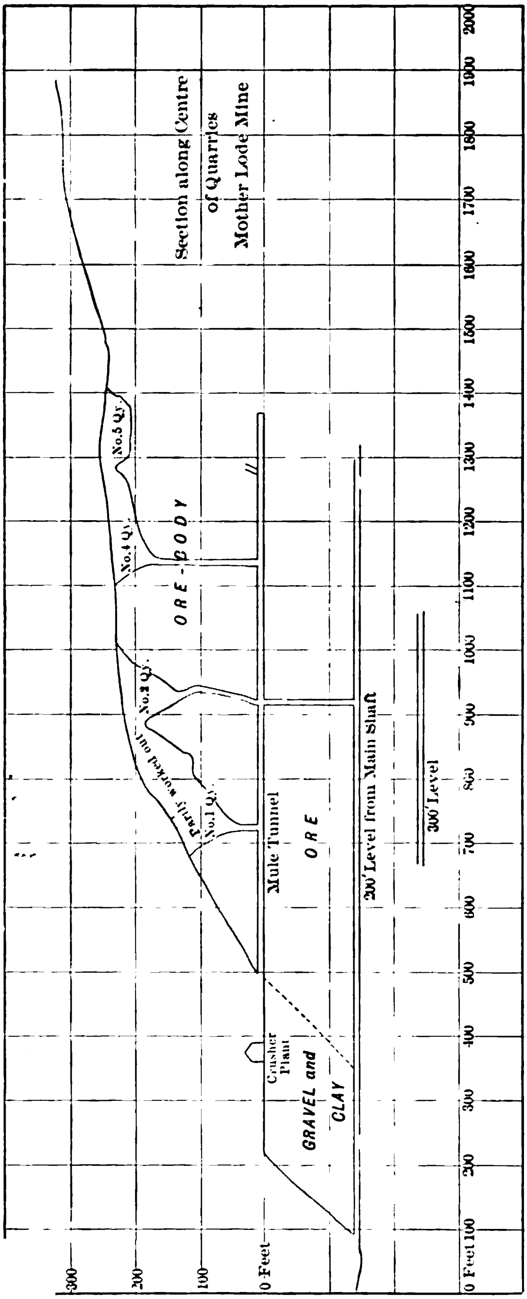
NO. 3 PIT, KNOB HILL MINE, WITH STEAM SHOVEL AT WORK.

No. 1 tunnel. No. 3 pit was started at the entrance to No. 1 tunnel and, of course, as it is advanced into the hill the entrance to the tunnel is carried back with the face of this open working. In this pit a steam shovel is used to load the ore, broken down by blasting, on tram cars which are hauled out and the ore dumped in a hopper above a big rock-crusher through which it is passed to the railway cars on the tracks below, for shipment thence to the smelter. The crusher, which is operated by a 100-horse-power electric motor, has jaws with an opening 42 by 30 inches, and it is designed to crush rock to a size of 7 to 8 inches at the rate of 150 tons per hour. Tunnels Nos. 2 and 3 have been started lower down the slope of the hill, on the Old Ironsides. Each gives 100 feet more depth, so that when No. 3 shall be under the highest point of the outcrop it will give a vertical depth of about 550 ft. But it is hardly probable an open quarry will be worked to that depth, owing to the risk to men working below from rocks becoming detached and falling from the faces or sides of the pits.

The greatest width of the ore body on the Knob Hill is stated to be about 400 feet, but the ore quarries have not yet been opened more than about a quarter of that width. This deposit is known to be continuous for at least 2,000 feet in length, from the Old Ironsides through the full length of the Knob Hill and thence into the Grey Eagle. It must be left to time and much more development work to show how much farther it extends, but since it has a known depth of at least 800 feet, where prospected in the Victoria by means of a diamond drill, there is assuredly an enormous mass of ore from which to mine and ship a large tonnage for many years. The output of ore whilst four furnaces are in blast at the company's smelter is from 1,200 to 1,400 tons per day, and, with the two additional furnaces lately put in also running, the tonnage will be increased to about 2,000 tons daily. To mine and ship this latter quantity of ore between 350 and 400 men will be regularly employed in the Granby Co's mines.

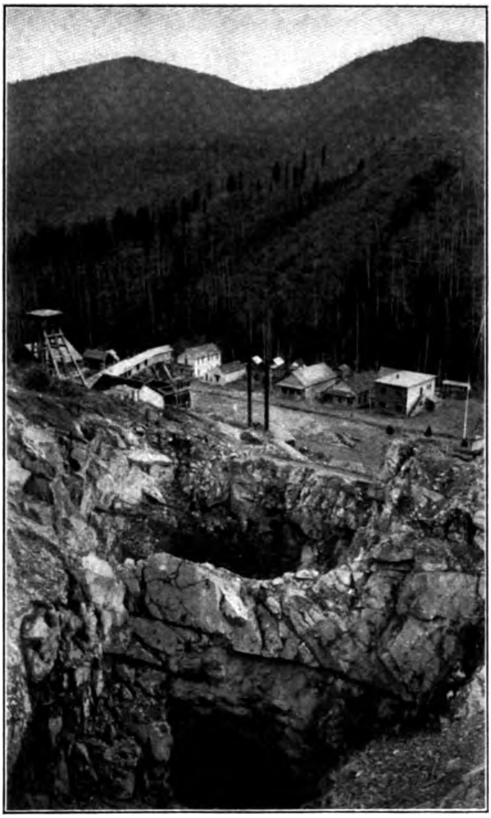
The B. C. Copper Company's Mines.—The British Columbia Copper Company owns the Mother Lode group of six claims, which are situate three miles west of Greenwood, whilst the Granby Company's mines are at Phoenix, five miles to the eastward. The ore body on the Mother Lode is similar in many respects to that above described, except that it has not yet been proved to be nearly so large. For several years development work was done underground, and much cross cutting and drifting at the 200 and 300-foot levels have proved that here, too, a large body of ore of a shipping grade is available. The lode is traceable by continuous outcroppings for some 1,100 feet north of the main shaft to where it disappears under heavy drift, whilst a

GENERAL VIEW OF THE GRANBY MINES, PHOENIX, B. C.



SECTION SHOWING METHOD OF WORKING, MOTHER LODE MINE, NEAR GREENWOOD, B. C.

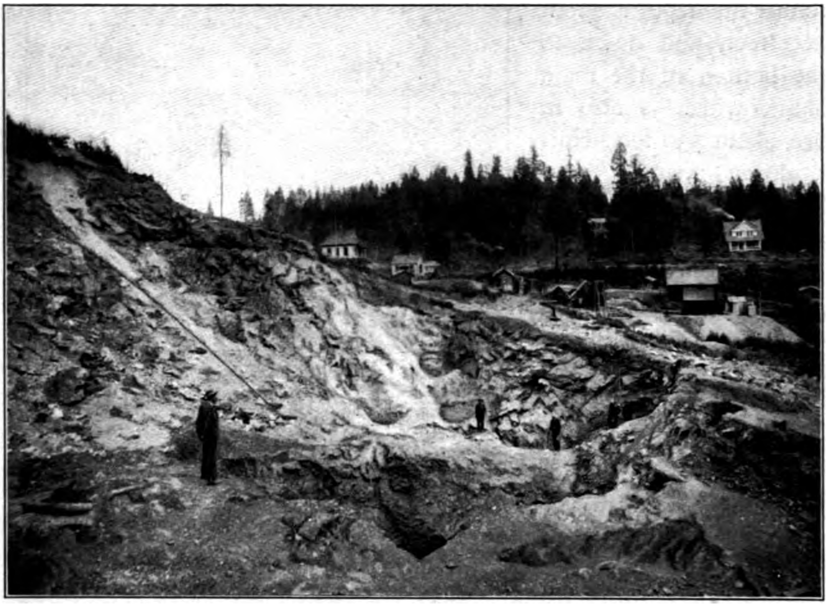
surface exposure about 700 feet from the shaft in an opposite direction suggests the probability of its extending at least that distance southward under the intervening drift. Its surface width varies from 80 to 160 feet. A main tunnel has been driven 850 feet into the hill on a level with a bench on which have been erected ore bins and other facilities for ore shipping. From this tunnel several exploratory cross cuts have been run to determine the width of the ore, and three big raises have been made to the quarries above. The main quarry was opened at a level about 110 feet above that of the tunnel, and other quarries below and above. From the highest point at which the ore outcrops on the hill down to the level of the main



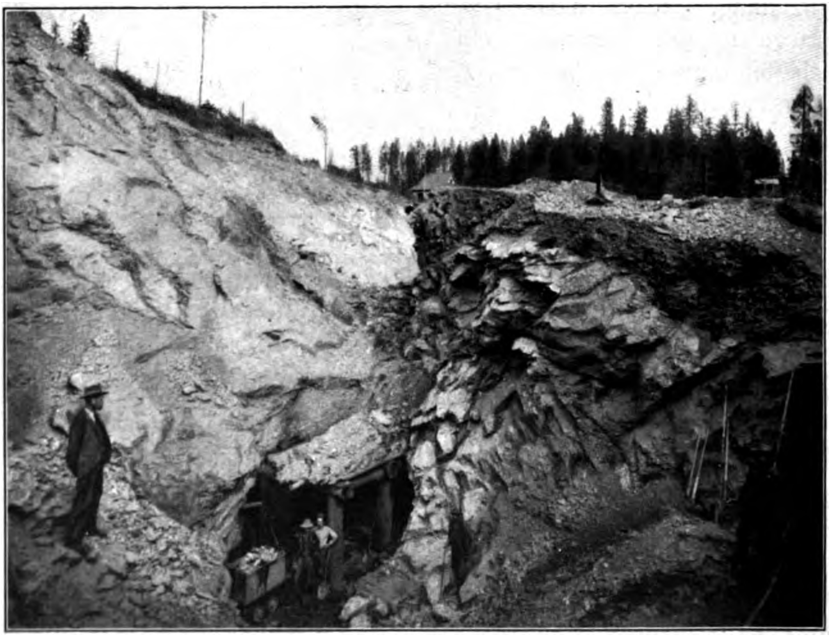
NO. I AND 2 QUARRIES OF THE MOTHER LODE MINE, SEEN FROM ABOVE.

tunnel the depth is about 260 feet, and down to the bottom of the main shaft, which is also in ore, about 530 feet. Half a dozen quarries have been opened at different places, those on the top of the hill giving a larger percentage of sulphur, which facilitates matte making in the smelter furnaces. The raises from the tunnel to the quarries are funnel-shaped at the top, so that when blasted down from the faces of the quarries, the ore may fall into them without handling. Rocks too large to pass through the bin gates of the hoppers at the bottom of the chutes are "bull-dozed." The ore is drawn from the chutes into 3-ton cars, which are hauled by mules to a rock crusher having a capacity of 65 to 80 tons of rock per hour crushed to a size not exceeding 5 inches. From the crusher pit an elevating machine raises the ore to shipping bins above the railway track. The Mother Lode is opened up sufficiently to enable it to maintain an output up to 1,000 tons per diem, whenever the company shall increase the treatment capacity of its smelter to require that quantity in addition to custom ores it also treats.

Snowshoe Gold & Copper Mines, Ltd.—The Snowshoe group is situate near Phoenix. Here, too, quarries have been opened in big bodies of ore, the full extent of which will not be known until after much more exploratory work shall have been done. Tunnels have been run in at two levels, raises made to open workings above, and

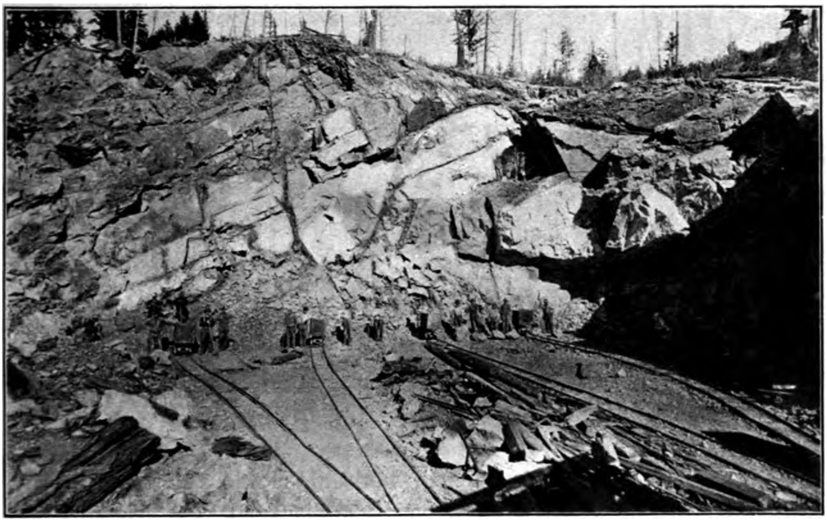


THE SNOWSHOE MINE QUARRY, SHOWING MOUTHS OF THE RAISES.



SNOWSHOE MINE. QUARRY BROKEN THROUGH TO THE UPPER TUNNEL.

the ore broken down in the same way as on the mines above described. The main three-compartment shaft is down 347 feet. At 140 feet it passes through the main tunnel, known as No. 1 level, from which all ore mined above that level is trammed to bins above No. 2 shipping track. Ore from No. 2 and No. 3 levels is hoisted in 2-ton skips, run in balance, and trammed to other bins, over No. 1 shipping track, which also receive the ore broken down in open workings above the upper tunnel. The mine is already in shape to ship 500 to 700 tons of ore a day, and as more room shall be made and more ore faces opened it will be practicable to increase the output steadily.



THE FACE OF NO. I QUARRY, MOTHER LODE MINE, NELSON, B. C.

Montreal & Boston Copper Company's Mines.—This company owns the Sunset group, adjoining the Mother Lode. The main shaft on the Sunset is down 400 feet, and several levels have been run between the surface and that depth. Above the 100-foot level a cross cut tunnel was driven through a big knoll of copper-stained rock which it is estimated contains at least 250,000 tons of ore. Raises from the 100-foot level to open workings in this big body of ore admit of the ore being broken down into chutes from which it is trammed to the shaft and hoisted thence to the shipping bins. The Montreal & Boston Copper Co. has its own smelter, with three furnaces, at Boundary Falls, whence Sunset ore is shipped to supplement custom ores.

Oro Denoro and Emma.—These mines are situate in Summit camp, near Eholt and about a dozen miles distant from Greenwood.

THE EMMA MINE WORKINGS, EHOLT, B. C.
Hall Mining & Smelting Co.

The Oro Denoro is operated by the Denoro Mines, Ltd., and the Emma by the Hall Mining & Smelting Co., Ltd., of Nelson, B. C. The Emma commenced shipping last year from a large deposit of ore, into which an open cut has been made about 50 feet in depth and 25 to 30 feet in width. Other openings have lately been made, and these show that here, too, ore occurs in such quantity as to give promise of a considerable output being continuously maintained. Ore quarrying on the Oro Denoro is of more recent date than on any other property in the Boundary, operations having only been commenced last June. Two quarries have been opened, both alongside the railway line. When visited early in August the removal of surface drift had exposed an ore body 69 feet wide, so far as uncovered, and dipping under the wash on both sides. A face of ore 30 feet in depth had been opened, and the steepness of the rise was giving additional depth as the quarry advanced into the hill. The second quarry was lower down the railroad and about 100 yards distant.

King Solomon and Copper Mine.—These are the only two properties as yet opened in the district in any considerable body of oxidised copper and iron ore. On the King Solomon an open cut was run into the hill and about 1,000 tons of ore, running much higher in copper than the general average of Boundary ores, were taken out. Similarly on the neighbouring Copper Mine claim masses of oxidised ore occur near the surface, as exposed in open-cut workings run for 93 feet in an ore body, the surface dimensions of which are about 174 feet by 84 feet. Lack of suitable transportation facilities is a present obstacle in the way of these properties shipping ore, the nearest railroad point being about five miles away.

That more big deposits of ore will yet be discovered in the Boundary may be taken for granted, for the district has not yet been extensively prospected and surface indications of the presence of mineral are frequently absent. Even the few now being opened up on an extensive scale have attracted much attention and their size and commercial value have occasioned surprise. The district has enormous possibilities, and it may be worth the attention of manufacturers of mining and smelting machinery and plant desirous of enlarging their business connections. Although it is only three years since smelting operations, with a single blast furnace, were commenced in the district, there are now three local smelting works having an aggregate of eleven water-jacket furnaces, and these are not nearly equal to the present ore-producing capacity of the mines now operating, so that considerable additions are even now required, and these will be made immediately a regular and adequate coke supply is assured. Space limitations prevent many details being given of plant and machinery already installed in the district, but it may be briefly stated that the Granby Co. has at its smelting works six blast furnaces, one tilting furnace, two stands of copper converters, seven blowers, two travelling cranes, plant for generating electric power, electric motors, two complete sampling plants with large rock crushers, briquette-making machine, and much more plant, whilst at its mines are two compound air compressors together rated at sixty 3¼-inch drills, two 700-horse-power electric motors to operate them, a big ore crusher with 100-horse-power motor, full steam equipment with air compressors, hoists, etc., timber framer with all appliances, machine shop equipped with modern power machines and tools, etc. The B. C. Copper Co. has two blast furnaces at work, two blowers, steam and electric-light engines, sampling mill plant, etc., and is arranging for making additions, and at its mine a forty-drill compound air compressor, large double-drum winding engine, rock crusher, elevating machine, etc. The Montreal & Boston Copper Co. has at its smelting works three blast furnaces, three blowers with direct-connected engines, sampling mill, and all the usual smelter equipment. All three smelters have ordered locomotives and slag trucks, for dumping slag hot. The Snowshoe mine has installed the high-pressure half of a thirty-drill air compressor, 150-horse-power double conical drum electric hoist, and other plant, whilst a dozen other mines in the district have steam power plants, and the Cascade Water Power & Light Co. has put in turbines, generators, transformers, and other equipment necessary for generating 2,000 horse-power, with the intention of later increasing to 6,000 horse-power.

THE ETHICS OF WORKSHOP MANAGEMENT.

By Egbert P. Watson.

Mr. Watson's writings on industrial subjects are always interesting and instructive, because they are expressions of the things he has seen and lived. He is emphatically an "insider" in shop affairs. Others of equal experience may hold differing views on important points; it is indeed probable that many managers would look to the melioration of trades-union aims and conduct, rather than to the decline of trades unionism, for hope of relief from the present ills of organised-labour origin. But Mr. Watson knows the American mechanic intimately and individually, and is on long familiar ground when he deals with the practical running of the shop.—The Editors.

A CONCERN that employed a very large number of men upon machine work some years ago discovered that they were not making any money, and as one step toward a remedy had decided to cut down wages. The nominal superintendent of the works was a Scotchman with very old-fashioned ideas as to shop methods and management of men, and one of the firm got an idea that he was the source of the discrepancy between outgo and income. He knew that it would be useless to undertake an investigation in person as to what went on in the shop during working hours, or the absence of the superintendent in other departments, for the reason that his presence anywhere in the vicinity would be discovered at once, and phenomenal activity in all departments ensue as a natural result; so he conceived the idea of putting on an assistant superintendent and seeing how that would work. He called the superintendent into the office and broached the project without any hint as to the reasons for the action, and asked him to name a suitable man for the place. He was of opinion that there was not any one in the shop capable of it, and suggested advertising for a man. This was not done, the firm having another plan in view, which was, in brief, to try one of the men in the shop first before taking any other steps. Curiously enough, the one selected was about the last any one unacquainted with his peculiarities would have chosen, being, as he was, a short-spoken, quick-acting workman with no external evidence of executive capacity. He was called into the office and asked if he would like to have the job; at first he demurred, but when it was explained to him that if he did not accept it would be offered to some one else, outside of the shop, he consented to try it and asked for instructions as to what was expected of him.

He was told that in future the general superintendent would confine himself to certain departments, and that the assistant would have other branches under his own special jurisdiction. No one but the firm would have control over him, or issue any orders, and he would be judged solely by results. It was clearly explained to him that the quantity of work turned out by the shops he had, or was to have, charge of did not come up to the mark, and since it seemed that the general superintendent had reached his limit, or had, possibly, too much to look after, it had been decided to appoint an assistant. The workman was then asked what he would need in the way of an office or locality to keep his records and blue prints in, and having given his views he departed to continue his work in the shop. No announcement of the addition to the officers of the shop was made by the firm for the moment, they being desirous of discovering if it would leak out through the workman himself, but after a week's delay, finding that the change was not common gossip, they came to the conclusion that, so far, the workman had shown that they had made a good choice.

A notice was then posted on the bulletin board that on and after a certain date John Doe would act as assistant superintendent in shops A, B, and C, and he was left to his devices. The firm thought that the new man might develop the weakness of favoring some of the men to the disadvantage of others, but nothing of the sort occurred; it appeared that he had "no friends to reward or enemies to punish," and that in all respects he justified the wisdom which prompted his choice. It transpired also that he had no pet theories, or systems of management, but simply went ahead to get the work out at the lowest cost and with the least delay—none at all in fact, because he took care to see that the machine tools were never idle except when they were stopped to take out, or put in, jobs, and as for the men themselves he took no notice of them whatever. That is to say, he did not fuss around them, harassing them by his presence, or intimate by word or deed that they needed watching. Some of them were shirkers, but after a brief experience of the new *régime* they disappeared and their places were taken by men who were willing to give a fair day's work for a fair day's pay.

The firm, when they appointed this workman as assistant over his fellows, felt that, possibly, there might be jealousy engendered which would militate against his usefulness, but this did not happen, for the men seemed to be glad that one from among them was chosen instead of an outsider and co-operated with him harmoniously in every detail. They said he was "a square man," and that it was a good shop to work in, which is the highest grade of certificate that can be given. When the new assistant came into power there were framed rules of conduct hanging on the walls of every department; men must do this and must not do that, under divers pains and penalties for disobedience, but by some mysterious agency they disappeared, and nothing whatever happened. The new man argued, possibly, that men cannot be made neat, orderly, punctual, and honest by codes, and therefore the latter were superfluous. For other measures tending toward improvement he had all blue prints to be worked from in his department delivered to him some weeks before they had to be put in hand, so that he could revise them and make requisition for bills of materials needed and have them going forward from other departments to his, in order that he would not have to wait for them when he was ready to do the job. So many shafts so long, such a number of machine castings as per pattern "C," bolts and nuts as specified—in a word, all the material for any given job under his hand. If he found any discrepancies in the blue-print details (sometimes he did) he would go to the drawing room and ask the draughtsmen personally who made them, if there was not an oversight, and point out the place. This kept good feeling toward him everywhere in the works, and all were willing to swear by him.

The man who has been described in previous lines is not a fictitious person to "adorn a moral and point a tale," but one who lived, moved, and had his being in New York City. He was a man from the ranks, and simply did his duty as he understood it and as he would be done by. He had no sinecure, either; it was not a little seven-by-nine shop, but a concern that employed 3,500 men when in full work, but he was equal to any number of men, in so far as his capacity was concerned, because he had executive talent and understood the men under him and what they had to do. He went further than the routine of shaper, planer, and lathe with them and was personally interested in all that concerned their lives and their families; without being intrusive he could sympathize with their troubles and trials, and very often helped them by advice and counsel. His advancement to a responsible position in the works was a distinct gain to them, and I wish I could add that, in due time, he was told to go up higher still; but it was not to be, for after a few years he passed on, higher than any position this world can give, and is remembered to this day by those who survive him.

Is it too much to assert that managers, like poets, are born, not made? It seems to me that it is true. I have seen plenty of so-called managers, persons in such positions, who hedged themselves about with the dignity that "doth become a king," and seemed to think that workmen belonged to the lower classes, so called, and would no more think of addressing them civilly than they would of consorting with them. These are the kind of managers who issue pronunciamentos, and rule by force, forgetting that the men can retaliate an hundred fold for every indignity put upon them. Where such officers are in power there is always dissatisfaction and misrule, because men will not do their best under such a condition of affairs, and good men will not put up with ill treatment for any amount of wages.

In a long and active life among workmen of all sorts of trades I have never found them unreasonable or exacting in any respect. There have been exceptions, of course, but these only prove the rule that if you do as you would be done by there will be less friction for all concerned. Owing to environment and the law of heredity—if there is such a law—there are, unfortunately, some natures which no amount of kind treatment can anneal or render tractable for the business of life. They do not comprehend the intentions of those who would befriend them and help them on their way; they are cursed from their mother's womb with the spirit of fractiousness and irritability, and make shops veritable hells if they are retained in them. I have had a few instances of this kind in the course of time, but I have never felt that it was right that many should suffer for the faults of one or two, and have had no compunction in dismissing them out of hand. I have had a gang of newly arrived Italians to deal with as handy men on drilling and laboring work about the shop, and if there is any class lower in the scale of humanity than they are I never met them. They are as strong as mules, and much slower so far as learning routine is concerned, for a mule can remember some thing; it seemed as if these men never would. They understood no word of English, but all directions as to what they should do had to be given by signs. Even these men knew when they were well treated, and divined the intention by some sort of intuition, as dogs do; after awhile, say a few months, they began to comprehend what was required of them, and it was almost pathetic to see the eagerness with which they tried to read the wishes of the foreman in charge. Low in the scale of intelligence as these men were, as we reckon that quality here, they knew when they were well treated and strove to show by their willingness that they appreciated it. Their attitude toward their employers serves to support my contention, as set forth in previous lines.

The older I grow the more confirmed I become in the view that the majority of American workmen do not need "management," so-called; they do not require to be watched in regard to their contract to render a fair equivalent for the money they receive. I have had some watch-the-clock men as well as others, but they were few and far between—half a dozen out of an hundred and fifty men, possibly—but even their fellows held them in low esteem, and saluted them when they were manifestly dawdling with "take your hands out of the bosses pocket and go to work." In other words, they let the "sojers" understand that their shortcomings were detected and repudiated. I said a few lines back that the majority of American workmen do not need management, and this assertion stands, so far as my personal experience goes, and that is not an exceptional one. I have had to take on men as they came to hand, so to speak, because when help is urgently wanted the first man who comes in is the best fellow, if he is at all possible, and is set to work. It may be that I have better snap judgment than some, or, from long association with those who live by the labor of their hands, can "size them up" as the phrase goes, and distinguish good men from bad with but a small margin of error; but whatever the reason may be, the fact remains that I have been well served, and hold American workmen in the highest esteem as personal friends—when time has shown me their worth. Even the misguided minority who have listened to the charming of the serpent of trades unionism still have my regard, in the hope that they will turn from the error of their ways and forswear forever allegiance to the alleged leaders of the movement. The majority of American workmen repudiate these men, as is shown by the few who have embraced the false doctrines so zealously preached, and I earnestly hope and believe that the day is not far off when American workmen will resume their individuality and independence, redeeming the mortgage which demagogues now hold upon these qualities.

Workmen are cosmopolitans, hailing from here, there, and everywhere; much going to and fro over the earth has rubbed off the prejudices and notions acquired by sitting down in a small town and coming to feel that its low horizon comprises all that is to be learned; they give and take more readily, and easily distinguish and detect the fair and square manager from one who is working them for all they are worth. They are easily managed, or are unmanageable, according to the way in which they are treated.

EDITORIAL COMMENT

WHEN after months of anxious—almost desperate — care and economy in 1897 the country began at last to feel sure of the returning tide of prosperity, no expression was more common than that "we had learned lasting lessons in prudence and conservatism." Starvation, or at least a very low diet, we were accustomed to say, had sobered us from our preceding state of industrial intoxication, so thoroughly that the reform was to be permanent. Hereafter we would be more cautious, less easily carried away by over-enthusiasm, and our progress would be far steadier and hard times would recur no more.

And taking the statement as it was intended to be applied—to the manufactures and industries of the United States—it has been well borne out by the facts. Never before, probably, did we keep our poise so well under conditions of so great temptation. So far as the physical side of our industries is concerned, and especially our engineering industries, we have shown a deliberation in expansion, a soundness and sense of proportion in putting forth new growth, that in itself now assures the health of the body industrial and its ability to endure a much more severe strain even than it has suffered from the antics of the cloud builders of Wall Street. The dominant factor in bringing this condition about is the technician. Trace back the story of any great enterprise —manufacturing, mining, metallurgical, transportion—and the genius of its success will be found to be the clear-sighted ability of a trained engineer. The past decade has seen his province vastly extended, and so far as his province goes the work is almost all sound—built for periods of storm as well as for pleasant weather and sunshine.

But the devils which were cast out of our industrial leaders, with the prayer and fasting of the last hard times, straightway entered into the leaders of Wall Street. The trust madness seized upon us, sevenfold more violent than the railway craze of a quarter century ago. A new order of "financiers" sprang into being, whose mouths watered at sight of the goodly properties created by the wealth-making ability of the engineer. The promoter arose and garbed himself as the "Napoleon of Finance". He took the solid work of the practical man as a suggestion with which to hypnotize his following, and they wandered in dreamland, seeing in visions rosy and magnified and manifold. The spell is failing, and the sober awakening is somewhat cold and depressing; but the solid ground is there, little shaken by the fall of the cloud palaces Wall Street built and common sense has destroyed. A craze has passed; certain idols have crumbled upon their feet of clay and fallen; the small investor, who bought wind and water—God help him and her! But the country is sound, and prosperity not likely to be very seriously checked.

In view of the developments of the past month, we are tempted to quote in this connection a few sentences from an editorial in our issue of October, 1903—just thirteen months ago:

"The flippant term 'Napoleon of Finance' embodies a fundamental truth. The same restlessness of conscious power, the same hungering for empire, the same craving for the intoxication of victory, now find in the field of industry the outlet that once was to be found only in the field of battle. And the same glamor of immediate success dazzles the people and throngs them about the victor, delirious in the glory of the present, careless of the stability of the future. But the same law underlies all nature, and will not be denied. The overblown bubble will burst—the overstretched fabric will break—the unstable structure will fall. * * * The analogy is plain. The American leaders of finance, beginning with undertakings which had economic justification, but since drunken with success, have expanded their campaign to the limits of dreamland. * * * When the 'financier' leaves the engineer and the industrial manager out of his counsels, the end of his triumphant progress is in sight. When success in floating securities is put above success in mechanical invention, in works organization, in labor handling, and in cost reduction, the defeat of the 'American invasion' is close at hand.

"A like recklessness led to Napoleon's winter campaign in Russia. What will be the suffering, and what the proportion of loss, in the impending retreat of the American Napoleons of Finance?"

* * *

THE arrival of the Mosely educational commission in the United States calls attention to the earnestness with which the problem of technical education and its relation to industrial progress is being studied in Great Britain. The value of the reports of the preceding industrial commission has been shown by the extent to which various portions have been *published and* reviewed, and we have no doubt that the work of the present party will receive an equal welcome on both sides of the Atlantic.

Among the members of the educational commission will be found the names of many eminent educators, and the opportunities which are being given to them to study the relation of technical education to modern industry should be of material value in the present emergency with which Great Britain is confronted.

That there is an emergency must be admitted, and one need turn only to the recent addresses of Sir Norman Lockyer and of Professor Boys, before the British Association, to realize how the matter appears to men of science. In fact, it is widely assumed in England that technical education has something very definite to do with industrial progress, and Mr. Mosely has arranged the visit of the commission to the United States to find out, if possible, what this connection is.

Naturally there is a difference of opinion as to the effect of a technical training upon a man who is afterwards to take an active part in the industrial world. Many men appear to think that technical education is a good thing on general principles, and that if you only have plenty of it somehow a favorable effect will be had upon general industry. Others insist that manual training is the thing, and that the schools must be a kind of cross between the college and the workshop, producing a sort of scientific workman ready for anything. As a matter of fact, various methods are applicable for various conditions, and no general rules can be laid down as to what shall constitute the one superlatively best system.

* * *

APART from the methods of education, which must, in great measure, be determined by questions of environment, the important matter is that the technically trained man shall be given opportunity to use what he has acquired, and become an active productive member of the community. As Dr. Louis Duncan says, elsewhere in this issue: "In the industrial battle being fought between nations, the most important weapon is an intelligent man technically educated."

Comparing technical education with military matters still further, what would be thought of a government which, after maintaining at great cost schools for imparting a thorough military education to thousands of young men, should take no interest whatever thereafter in placing them in suitable posts where the benefits of their training could be secured? When men have been educated for the art of war they are promptly placed where they shall give some return to the government by which they have been educated, and there is no manner of doubt as to the value and effectiveness of the trained soldier over the uneducated recruit, no matter how enthusiastic and earnest the latter may be.

Here then is the crucial point in the connection between giving the education and reaping the benefit. It is not enough to provide ample facilities for an army of young men to obtain the best sort of a technical training; there must be added to it such a connection between the school and the manufactory that the transfer from the one to the other shall be direct and continuous; the men must not only be trained, they must also be used. To give a man a special education, and then to turn him adrift to find lodgement where he may, is a line of conduct which, if practised in military affairs, would instantly meet with loud and well merited denunciations, and yet who can say that this is not too often the method, or lack of method, existing in many places, in connection with technical training?

It is not to be expected that the technical school shall of itself form the connection between the giving of the education and the application of the results. The military academy does not place the men in the army; that is already provided for elsewhere. It is to the employers, to directors of great enterprises, to men who use men, and who know how to use them, that the appreciation of the technically trained graduate must be taught. Many leaders of industry know already the importance of securing the services of technically trained men, and in the United States especially, are the graduating classes of the technical schools in continual demand for immediate service in the workshop, the factory, and the mill. This phase of the question will be fully treated from concrete examples in the succeeding issue of the Magazine, but we may emphasize here that this is the great difference between technical training in England and in the United States. We feel warranted in saying that the members of the Mosely commission will not find what they seek in the class rooms of American colleges and schools, nor yet even in the mechanical laboratories and departments of original research. England possesses many technical schools of high standing, but who can say that the British manufacturer stands anxiously waiting to secure the graduates to give them positions at living wage, without premium, desiring only to reap the benefit of the latest information, and freshest methods in the prosecution of his work? True, there are some far-seeing men in England, who appreciate the value of what others have been throwing away, and we have already spoken in these columns of the good work initiated by Mr. Yarrow in advocating the abolition of premiums and urging the payment for services of student apprentices, but the work has but been commenced, and by far the greater number of British employers still hold to the older methods.

If the Mosely commission will study the connection between the school and the shop, if they will visit the great manufacturing establishments which have been foremost in pushing the products of American industry to all parts of the world, they may there find the secret of the relation of technical education to industrial progress, for they will see shops filled with men from the technical schools, they will discover how the latest scientific methods and appliances are produced and intelligently used to forward American industry. England has educators who are the peers of any in the world, and it is men rather than methods that make the true eminence of educational institutions. What she lacks is not improved methods of teaching, but intelligent appreciation of the right use of the men she is already training. Not all of the twenty-four millions for which Sir Norman Lockyer asked will avail her if she persistently fails to use the products of the technical schools for which he pleads so powerfully. It is her employers who need awakening; her educators are wide awake already, but their work is but half the task.

* * *

It is not always easy to regulate things beyond our power, and in the semi-official reports which have been made public concerning the work of the wireless-telegraph congress we are strongly reminded of the conference of the mice when they decided that it would be well to put a bell upon the cat.

Having found that telegraphic messages can be sent through space without official permission, and even without the source being directly discoverable, the officials of various governments promptly assumed that they could control these performances, and solemnly assembled in congress to take possession of the ether and issue rules for the regulation thereof.

With such limited information as is available concerning the work of this assembly, it appears that they soon discovered that the ability to enforce their enactments was limited to terminal stations on their own territory, and that even in such instances the power of control was not absolute. Two resolutions, however, were adopted, the first of these ruling that all coast stations shall be obliged to receive and transmit all telegrams for ships at sea without regard to system, and shall give precedence to appeals for help, and also regulating the tariff for the land portion of the transmission; and the other asking the various operators to be good, and not interfere with each other any more than absolutely necessary.

* * *

As long ago as 1831, when Darwin made his famous "voyage of a naturalist" in the Beagle, the longitude of the various islands in the Pacific was determined by the comparison of local with Greenwich time, the ship carrying a large number of chronometers in order to insure especial accuracy for this, the main object of her cruise. Now, however, this determination has been made with a far greater degree of accuracy, by reason of the completion of the Pacific cable. By comparing the telegraphed time from points of known position, such as Vancouver on the Pacific coast and Brisbane in Australia, the relation of these ports to each other and to the intermediate points on Fanning island and on the Fiji islands have now been positively determined, and thus the girdling of the globe is completed.

THE INFLUENCE OF SCIENCE UPON INDUSTRY.

THE INFLUENCE OF BRAIN POWER UPON HISTORY—ORGANISED SCIENCE AND NATIONAL COMMERCIAL SUPREMACY.

Sir Norman Lockyer—British Association.

IT has become the fashion of late to poke fun at the British Association for the Advancement of Science, and to seize upon the addresses and discussions as suitable material for alleged humorous comment. This tendency appears in most of the comments upon the addresses at the recent meeting at Southport, notwithstanding the fact that the speakers were among the notable men of science of the United Kingdom; holding offices which have been filled by such leaders of thought and work as Tyndall, Huxley, Kelvin, and Stokes. It is easy for the newspaper paragrapher to take such an address as that of Sir Norman Lockyer as material upon which to fling his clumsy wit, but certainly Sir Norman can stand it with serenity and silence, while those who care to think and study his words may well forget the attacks and devote themselves to doing their share in aiding the progress of the cause which has been so well advocated.

Once upon a time history consisted almost altogether in accounts of the battles and campaigns of the soldiers of the nation whose story formed the subject of the narration; the brutal stage was still on, and fighting was the only thing worthy of record. By and by a great discovery was made, and it was found that the real life of the people was entitled to some share in the history of a people, and great was the applause which fell to the fortunate writers who exploited the new school of annals. Even these, however, failed in great measure to realize that the accounts of local political campaigns, of religious squabbles, and of agricultural and commercial relations formed but a portion of the true history of a nation, and both soldiers and politicians are most reluctant to admit that the power which they have fondly fancied to be entirely their own must be shared with the men who really do the things which change the face of the earth and the conduct of affairs, with the engineers, the scientists, the professors, and the students of their own and of all other nations. It is this side of history, and it is this kind of brain power of which Sir Norman Lockyer speaks, and his words may not well be ignored.

Thus, in introducing his subject, he says:

"I think, although it is not generally recognised, that the century into which we have now well entered may be more momentous than any which has preceded it, and that the present history of the world is being so largely moulded by the influence of brain-power, which in these modern days has to do with natural as well as human forces and laws, that statesmen and politicians will have in the future to pay more regard to education and science, as empire-builders and empire-guarders, than they have paid in the past.

"The nineteenth century will ever be known as the one in which the influences of science were first fully realised in civilised communities; the scientific progress was so gigantic that it seems rash to predict that any of its successors can be more important in the life of any nation."

It does not yet seem to be fully realised by those to whom the conduct of affairs in Great Britain has been intrusted how great a part in her past power has been played by the forces and methods which they so easily ignore, and while they perceive and deplore the decline of national industries from which a great portion of the national wealth has been drawn, they are unwilling to admit that a large portion of that decline has been due to the neglect of scientific education and scientific methods of work and thought.

There is little doubt that by the middle of the nineteenth century Great Britain was far in advance of the rest of the civilised world, and that this pre-eminent position was due both to the magnitude of her natural resources and to the extent to which she had availed herself of the development of scientific methods of work. The application of science, and the development of engineering gave her command of her own resources and control of the sea, a combination which made her the richest country in the world, "the seat and throne of invention and manufacture."

But, as Sir Norman Lockyer points out, there is nothing so cosmopolitan, so international, as the development of science, as although Great Britain had a long start of the rest of the world in the practical applications of scientific methods, she could not expect to retain that lead without continual and strenuous effort. The resources upon which England has had to depend may be divided into two classes, her material resources and her mental resources. The former have naturally been subject to decline, being under a continual drain of accelerating proportions, while the latter, the portion wholly under human control, has been greatly neglected.

Says Sir Norman Lockyer:

"So little did the bulk of our statesmen know of the part science was playing in the modern world and of the real basis of the nation's activities, that they imagined political and fiscal problems to be the only matters of importance. Nor, indeed, are we very much better off to-day. In the important discussions recently raised by Mr. Chamberlain, next to nothing has been said of the effect of the progress of science on *prices*. The whole course of the modern world is attributed to the presence or absence of taxes on certain commodities in certain countries. The fact that the great fall in the price of food-stuffs in England did not come till some thirty or forty years after the removal of the corn duty between 1847 and 1849 gives them no pause; for them new inventions, railways and steamships are negligible quantities; the vast increase in the world's wealth in free trade and protected countries alike comes merely according to them in response to some *political* shibboleth.

"We now know, from what has occurred in other States, that if our Ministers had been more wise and our universities more numerous and efficient, our *mental resources* would have been developed by improvements in educational method, by the introduction of science into schools, and, more important than all the rest, by the teaching of science by experiment, observation and research, and not from books. It is because this was not done that we have fallen behind other nations in properly applying science to industry, so that our applications of science to industry are relatively less important than they were. But this is by no means all; we have lacked the strengthening of the national life produced by fostering the scientific spirit among all classes, and along all lines of the nation's activity; many of the responsible authorities know little and care less about science; we have not learned that it is the duty of the State to organise its forces as carefully for peace as for war; that universities and other teaching centres are as important as battleships or big battalions; are, in fact, essential parts of a modern State's machinery, and as such to be equally aided and as efficiently organised to secure its future well being."

Assuming, then, that it is the duty of the State to foster its mental, as well as its military strength, Sir Norman Lockyer does not mince matters, but boldly demands as much money for the establishment of universities and technical schools as is expended upon the maintenance of the navy. There is no manner of doubt that if the sea power of the kingdom is not kept up, and even increased as the power of other nations is developed, the safety of the nation cannot be assured. In like manner, it may well be maintained, if the brain power of the nation is neglected, the material and commercial power of the country must decline. It has been said that England has to regard the increasing armaments of other nations as a menace, while the advances made by all the rest of the world in science become hers as well, there being universal free trade in ideas, although not as yet in commodities. To wait calmly, however, and permit the rest of the world to make the technical progress and at the same time develop natural resources, in the hope of being able later on to gather what has been made public, is hardly the position for a nation to assume which has so long been accustomed to lead; a policy of "muddling along somehow" will not appeal to thinking scientific and commercial men at this late date.

The power of education and technical training to strengthen the position of a nation is well seen in the instances of Prussia after Jena and of France after Sedan, and to the development of education in both countries their tremendous increase in national power must be attributed. Japan, also, may be cited as a nation which has raised herself to the peer of the modern powers of Europe in less than a generation by appreciating the power of scientific training in strengthening a nation.

Space is here lacking to discuss this great subject in detail, but enough has been said to draw attention to the plans laid before the British Association by its President. That the time must come when the influence of national science upon national strength is realised, we fully believe, and the advent of that time may well be hastened by such appeals as that which has been made by Sir Norman Lockyer.

THE GRAND CENTRAL RAILWAY OF EUROPE.

A PROPOSITION FOR A NEW INTERNATIONAL RAILWAY SYSTEM FOR CENTRAL EUROPE THROUGH FRANCE TO THE SEA.

Louis Lafitte—Le Génie Civil.

WITH the approaching completion ot the Simplon tunnel and the consequent outlet which it will give to the route of the Simplon-Jura railway into Italy, the effect upon the railway systems of central Europe becomes a matter for consideration. Especially will this fresh opening through the barrier of the Alps affect the railway business of France, adding as it does, a fresh competitor to the Mont Cenis route, unless further provision is made to retain the traffic to France by the provision of better connections.

In a recent paper in *Le Génie Civil,* M. Louis Lafitte discusses the whole situation, and shows how it may be possible to turn what at first appears to be a serious inroad into the railway business of France into an addition to her transportation facilities between central Europe and the transatlantic ports.

With the first piercing of the Alps by the Mont Cenis tunnel the traffic from Italy passed directly into and through France to French ports, but the completion of the St. Gothard route, assisted, it is maintained, by German influence and financial aid, diverted much of this business from France, and assisted in the development of the commerce of Genoa and the North Sea ports, to the disadvantage of Marseilles. By the St. Gothard route Genoa was placed more than 100 miles nearer to Bâle than is Marseilles, and the result of this advantage has distinctly appeared in the relative growth of the business of the two cities, that of Genoa increasing much more rapidly than that of Marseilles. With the completion of the Simplon tunnel the advantage of Genoa over Marseilles will be still greater increased, unless some modification in French railway connections is made to modify the traffic conditions.

In discussing the general rearrangement of transport relations which may be made consequent upon the completion of the Simplon tunnel and its connections, M. Lafitte examines profiles of the different routes by the Mont Cenis, St. Gothard, and Simplon, showing the additional construction which must be made if the connection between Milan and Paris is to be improved. Three routes are examined, first by way of Pontarlier, and Lausanne to the Simplon; second, by Bellegarde and Saint-Gingolph, also to the Simplon, and third, by Lons-le-Saunier, the Col de la Faucille, and Geneva, connecting direct with the Simplon-Jura railway through the Simplon tunnel to Milan and the Italian railway system. All three of these routes materially shorten the distance over the existing connections by Mont Cenis or by the Saint Gothard to Paris, but the last of the three is the one especially advocated by M. Lafitte. Summing up its advantages, he says that it would reduce the distance between Geneva and Paris from 605 kilometers to 488, or 20 per cent., while the total distance between Paris and Milan, now 1,441 kilometres by the Saint Gothard route, would be reduced to 1,039 kilometres by the combination of this connection and the Simplon tunnel route, a gain of 402 kilometres. This latter corresponds to a reduction of fully two hours in the time between Paris and Brindisi for the Oriental mails.

But, in the opinion of M. Lafitte, the shortening of the connections between Milan and Paris is but a portion of the benefit to be gained by the opening of a direct French connection to the Simplon tunnel route. The true advantage to be gained includes the opening of a trunk line across France, connecting Switzerland, Italy and the Adriatic with an Atlantic port on the coast of France. Such a port he finds in Saint Nazaire, at the mouth of the Loire. Given the proper railway connections, such as would be obtained by the construction of the connecting portion through the Col de la Faucille to Geneva and the Simplon, the port of Saint Nazaire would become to France what Hamburg and Bremen are to Germany, offering a direct communication to transatlantic navigation which would make France the most advantageous country through which to make communication with the whole of southern Europe.

At the present time there is no complete railway system across France, all the lines running to Paris and communicating to the North Sea ports, while the narrowest part of the country really offers the most direct route for connection to the sea. The railways for this cross-country are already in existence, and it requires only the construction of the short connection through the *Col de la Faucille* to bring the Paris, Lyons, Mediterranean line into a close working union with the Simplon-Jura system, together with the establishment of trunk line relations with the remainder of the system, to place France in complete command of all the advantages which will arise from the completion of the Simplon tunnel.

Until now the gain to be expected from the piercing of Monte Leone has been expected to follow from the shortening of the distance from Milan to Calais, Ostend, and the coast of the North Sea, and the advantage thus given to Genoa has been expected to work injury to France by the effect upon the traffic of Marseilles. If, however, the line proposed by M. Lafitte, and called by him the "Grand Central Railway of Europe," be constructed, France will be the principal gainer by the Simplon tunnel, even though the trade of Marseilles with the north is undermined.

A feature of this proposed route which appeals especially to the French imagination, is the fact that it would provide an "all-Latin" communication to the Orient. Connecting directly with Italy through Latin Switzerland, all passage through Germany would be avoided, and it would become possible to compete to material advantage with the present "Orient-Express" route by way of Strasburg, Munich and Vienna.

The paper of M. Lafitte shows in an interesting manner the extent to which facilities create traffic. When the Mont Cenis tunnel was completed it was assumed that it would be able to take care of the travel between France and Italy for many years. Soon, however, the Saint Gothard tunnel was built and ample business appeared for both routes, while the increasing demand for communication through the Alps has led to the expenditure of millions in the piercing of the Simplon. Already before the passage is opened the anticipated traffic is offered as an incentive for the opening of additional railway routes from the tunnel to the sea, and even if the plans for a new central route through France are not at once executed, it may well be expected that the connections with lines already existing will find ample business. Under such circumstances the time will soon come for the enlargement of the auxiliary Simplon tunnel and the opening of the double track.

POSSIBILITIES OF LIQUID FUEL.

THE ECONOMY OF INTERNAL-COMBUSTION MOTORS USING LIQUID FUEL IN COMPARISON WITH STEAM ENGINES AND BOILERS.

Rudolph Diesel—Verein Deutscher Ingenieure.

LIQUID fuel is continually coming in for more and more attention, both as used under boilers for the generation of steam and for combustion directly in the cylinder of the internal-combustion motor. The former aspect of the subject has been dealt with fully in the pages of this magazine by Professor Williston, and now in a paper by Mr. Rudolph Diesel, in the *Zeitschrift des Vereines Deutscher Ingenieure,* is given the latest information concerning the latter portion of the question.

The work which Diesel himself has done in the development of the oil-burning motor is well known. Taking the theoretical cycle of Carnot, he has designed an engine which reproduces in a close degree the same succession of thermodynamic events, with the result that the highest known thermal efficiency has been realized in motors of his design. Furthermore, by the employment of very high degrees of compression, he has succeeded in securing such a complete combustion that heavy petroleum residues are burned as fully and completely in the cylinder as are the most volatile essences, the thermal efficiency being equally high for all kinds of liquid fuels.

But it is not intended here to re-discuss the Diesel motor. In his latest paper Mr. Diesel examines the broad subject of the direct use of liquid fuel in internal-combustion motors, and shows that its rapid growth during the past five years renders it a notable question in the domain of power generation.

Taking the thermal efficiency of the best modern triple expansion steam engine, using high pressure and superheating, and considering this as unity, we have the following comparisons for internal-combustion motors. The gas engine, using lean furnace gases, has a relative efficiency of 1.27; the so-called "spiritus" motor, using the light, volatile hydrocarbons, as in many automobile vehicles, stands at 2.08; while the Diesel motor, burning heavy crude oils directly in the cylinder, without employing anything corresponding to the carburetter, has a thermal efficiency of 2.27. Comparisons based on the relative costs of the different fuels naturally adds to the advantage possessed by crude petroleum, paraffine, and other heavy oils, and hence the economic efficiency of the Diesel motor is even higher when considered upon a commercial basis than when the thermal efficiency alone is taken.

As Mr. Diesel clearly points out, the question of the efficient use of fuel in the generation of motive power has become something far greater than the mere matter of saving a certain proportion of operative cost. It is rapidly becoming a controlling element in establishing the location of commercial centres. There is little doubt that the economic importance of Great Britain, apart from her geographical position and maritime strength, has been largely due to the possession of abundant stores of coal. With the increasing cost of that fuel the necessity for greater efficiency in its use is beginning to be realized. At the same time the advent of motors burning liquid fuels with a thermal and commercial efficiency of more than double that of the best steam engine is naturally strengthening the competition with countries possessing abundant stores of petroleum. In the recent discussion of the paper upon the Diesel motor by Mr. Ade Clark at the Leeds meeting of the Institute of Mechanical Engineers, the success of the motor in England was shown to depend, to a great degree, upon the cost at which the liquid fuel could be delivered at the point where the power was to be generated. This being the case, the tremendous advantage of locations, such as south-eastern Russia, western Pennsylvania, Texas, southern California, etc., naturally appears. Mr. Diesel gives in his paper a map of the world, upon which the present centres of natural supplies of petroleum are indicated, and a study of this map reveals the fact that certain places would necessarily assume much greater importance industrially than they for such a system of instruction in general mathematics which shall be adapted for the use of the present and prospective engineer, but such instruction must come from those who are themselves practical engineers and who have grasped the needs of the situation from their own working contact with the problems of the day. The language should be that of the workshop and the field, the examples must be drawn from the problems with which the mechanic and the designer is daily confronted, and the methods must be such that the man who has already grasped the behaviour of the forces under consideration shall see those forces treated intelligibly, without any shirking of the results which he has found by bitter experience, must be encountered.

It has been said that the skillful engineer and mechanic must always be a truthful man because he knows that deceptions cannot be practiced when the actual work is assembled. He cannot force a balance and make two things which are unequal look equal by saying so in some juggling fashion. For him the sum is always equal to the total of all its parts, and if he has erred in the dimensions or arrangement of those parts the truth will out to condemn him.

A school of mathematics for such men must be something different from that which is now taught, and when such a system is forthcoming the engineer, of all men, will give it grateful welcome and use.

RESISTANCE OF ROAD VEHICLES TO TRACTION.

INFLUENCE OF ROAD SURFACES, GRADES, TYRES, AND MATERIALS UPON THE RESISTANCES TO AUTOMOBILES AND OTHER VEHICLES.

Report of British Association Committee.

AMONG the interesting communications presented at the Southport meeting of the British Association for the Advancement of Science may be noted the report of the committee to whom was entrusted the investigation of the influences of roads to the motion of vehicles.

The absence of reliable data upon this subject, and its growing importance in connection with the development of automobile vehicles renders scientific determinations under acual conditions most desirable, and the report, so far as it goes, has added materially to the stock of information.

After describing improvements which had been made in the traction dynamometer with which the tests were made, the report goes on to describe experiments made upon iron tyres on wheels operated at various speeds and under different loads. These trials, made on a level road paved with stone setts, 6 in. by 3 in., with spaces of one inch between them, gave results which when plotted as curves furnished some interesting information. Thus, in each case the resistance increased with the velocity, but at a diminishing rate, the curves having a concave side downward. This may be due to the fact that as the wheel travels faster it has less time to fall into the little hollows in the roadway, merely skimming along the tops of the ridges. This view is borne out by the experience of riders on bicycles, who know by experience that a road paved with stone blocks is less rough when traversed at a high speed than when a slower pace is maintained. Comparisons of the resistance curves for stone blocks and for macadam show that a smaller tractive effort is required for the former than for the latter. Upon investigation the reason for this is apparent. Consider two perfectly level roads, one made with setts and the other with macadam. The setts present a surface which is extremely hard, although possibly irregular, but this irregularity with well-laid setts is more apparent than real, as the tops of the setts themselves are smooth and level and all in the same plane. On the other hand, the macadam, although quite level, is not nearly so hard as the stone surface, and is, moreover, covered with a thin layer of dust or fine gravel, which, as well known, retards the progress of a vehicle.

The experiments with iron tyres showed that for a 40-inch wheel with 3-inch face, the resistance was about 25 pounds, when running at a speed of 6 miles, and carrying a load of 672 pounds; while the same wheel showed a resistance of 35 pounds at 10 miles, and about 38 pounds at 12 miles speed, similar results being obtained with other loads.

Similar experiments were made with pneumatic tyres, the wheel in this case being a light wire-spoke wheel, 24 in. in diameter with 2¾ tyre; these trials being made upon a level macadam road in fairly good condition, the results being plotted in curves.

With these experiments it appears that the ratio of tractive effort to load is very nearly constant, and that the tractive effort increases but slightly with the velocity, the lines being almost straight, with a small angle with the horizontal axis. From these trials a diagram for the tractive effort per ton for different velocities has been made, this showing a resistance of 128 pounds per ton at 7 miles per hour, and 148 pounds at 16 miles, the resistance increasing at a rate of a little less than 2 pounds per mile. By taking the resistance as directly proportional to the load and inversely proportional to the diameter of the wheel, the value for other operative conditions may be computed. The real relation between wheel diameter and tractive resistance is not exactly known, but the above rule agrees with the experiments of Morin, and may be considered as fairly near the truth.

The much discussed subject of the benefits of wide tyres is also considered, this having been especially examined by Mr. Diplock. one of the members of the committee. He started with the following assumptions:

1. All wheels are coned or straight in cross-section.

2. All roads are arched or flat in cross-section.

3. It seems evident that coned wheels on flat roads or flat wheels on arched roads cause increased road resistance in proportion as the wheels are coned or the roads arched in relation to each other, and that the same result is caused by inequalities in the road surface, viz.: that wide tyres do not obtain an even bearing throughout their entire width, except on very soft and yielding ground.

Starting from the above statements, and as the results of long experience and observation, he had come to the conclusion that for heavy traffic wheel tyres of more than, say, 9 in. in width, have, in practice, little or no material value as tending to reduce road resistance or damage to the road surface, and he suggested that experiments might be carried out with a view to testing the accuracy of this conclusion.

Assuming that 9 in. were adopted as a useful maximum width of tyre for heavy haulage on average roads, he submitted the following theory:

1. That the supporting power of a road is limited by the cohesive friction of the road molecules or particles against each other.

2. That this supporting power limit varies very considerably according to the material used in constructing the road and the moisture absorbed in the road.

He would be prepared to find that road resistance up to certain limits of weight on each wheel (for each class of road) varies approximately in direct proportion to the increased weight on each wheel.

He was of opinion, however, that if this limit of weight per wheel is exceeded so as to overcome the frictional cohesion of the road molecules against each other, then an entirely new set of conditions arises; and he would be prepared to find that road resistance would, under such conditions, increase altogether out of proportion to increased weight on the wheels.

He urged that the committee take steps to ascertain:

1. The maximum useful width of tyre for heavy traffic on average roads.

2. The limit of weight on each wheel (for various classes of road) up to which road resistance increases in direct approximate proportion to the increase of weight on each wheel.

3. The rate of increased road resistance when that limit is moderately exceeded.

The report also includes some interesting information gathered at the recent international congress of automobilism in Paris.

Experiments made by M. Jeantaud with a electric vehicle gave results which are eminently practical, since the resistance was determined by measuring the electrical energy required under actual running conditions. With a vehicle operating with a load about 4,000 pounds, 1,760 watts was required to maintain a speed of 9.32 miles per hour, and making an allowance of 15 per cent. for motor friction the energy of propulsion was 1,496 watts. Working this out in English units a tractive effort of 46 pounds per ton is obtained.

Other experiments by M. Jeantaud upon

roads in various conditions show the influence of the surface upon the resistance. Thus upon a muddy road, with the same vehicle and under conditions otherwise similar to the above, a tractive effort of 74 pounds per ton was measured. The same road, when very smooth, and hardened by frost, offered a resistance of only 42.7 pounds per ton, and in general the resistance of a muddy road appears to be about double that of a smooth, hard road.

The question of the powering of automobiles naturally is included in the discussion of the resistances which the power must overcome, and in this respect some interesting points have been developed. Acting upon the principle that dead weight is to be avoided, the builders of vehicles have endeavored to reduce the weight of their machines per horse power developed, and a marked progress has been attained in this respect. Thus, according to M. Lavergne, the run from Paris to Bordeaux was made by Levassor in 1895 in a 4 horse power car weighing about 1 ton, or 1 horse power for 550 pounds dead weight. In 1896 this weight was reduced to 365 pounds per horse power, and by 1900 it had fallen to 90 pounds.

In the recent Paris-Madrid race, one car entered was of 100 horse power, the weight of which represented only 22 pounds per horse power, and in the case of motorcycles this has been still further reduced.

It is a question, however, whether such a reduction in weights is wholly advantageous. Apart from the narrow margin of safety which is allowed, and the Paris-Madrid fiasco showed how close this margin was, a certain proportion of weight is necessary for traction.

An extremely powerful motor must be accompanied by a comparatively heavy load, otherwise the wheels do not bite well, and energy is wasted. As M. Lavergne well says: "Instead of building very powerful, yet extremely light motors—the durability of which is questionable—would it not be better to rest content with a vehicle of smaller power, and use it more effectively?"

An important matter in connection with the investigations of the committee appears in the announcement that negotiations have been made by which experiments conducted upon heavy traction vehicles by the Mechanical Transport Committee of the War Office will be placed at the disposition of the Association, so far as this work may relate to matters other than military. It is to be hoped that in this way much valuable information will be gained to form matter for future reports.

THE ACTION OF SEA WATER ON ALLOYS.

EXPERIMENTS UPON THE CORROSION OF COPPER, IRON, AND NICKEL ALLOYS BY PROLONGED CONTACT WITH SEA WATER.

Investigations of the German Navy.

SEVERAL years ago we discussed in these columns the investigations made by Chief Engineer Diegel, of the German Navy, upon the corrosive action of sea water upon different bronze alloys after prolonged immersion. We now quote results by the same experimenter, and from a recent issue of *Glasers Annalen* we abstract some account of the work which has been continued.

The previous experiments were made especially with copper alloys, containing zinc, tin, and aluminum, the specimens being taken from the metals practically used for the sheathing of vessels, and the tests included immersion in sea water for 2 to 2½ years. The general result of these experiments showed that an important influence was exerted by the material with which the sheathing was in contact, there being a distinct galvanic action. The relative position of attached metals in the galvanic scale appeared to govern the rate of corrosion, and metals which resisted well when in contact with those which were electro-negative towards them, became rapidly corroded when in contact with electro-positive metal.

In the present investigations the question of the influence of the purity of the material upon the corrosive action is considered, and the extent to which the presence of impurities retards corrosion is studied. Thus specimens of electrolytic copper, 99.955

per cent. pure, were immersed in sea water beside pieces of ordinary commercial copper, this latter being 98.98 per cent. pure, and containing 0.6 per cent. of arsenic. The pure copper was rapidly corroded, the metal being eaten away fully 13 times as fast as was the impure specimen. It might be supposed that the two specimens formed a sort of galvanic couple, the pure copper becoming an anode, and consequently eaten away, but further experiments upon the hulls of two boats, one sheathed entirely with the pure copper and the other with the common material showed similar results. At the same time it could not be supposed that no galvanic action took place under these latter circumstances, so further experiments were made, with interesting results. Thus, the marked difference in the corrosion of rods of pure and impure copper disappeared when the two specimens were electrically insulated from each other. Also when a sheet of electrically pure copper was allowed to become oxidized in spots before immersion in the sea water, the bare portions were soon deeply eaten, thus showing that the copper formed a galvanic element with its own compound, the pure metal becoming the anode and consequently the portion to be attacked. The fact that homogeneity played an important part in the action was shown by the fact that annealed copper was far less rapidly corroded than hard-drawn metal having a much higher resistance and elastic limit.

Coating the copper with zinc, commonly miscalled galvanizing, protects it for but a short time, and as soon as portions of the zinc are worn off the corrosion proceeds more rapidly than ever. Contact with iron, however, causes the copper to be much less rapidly eaten than when it is immersed alone in the sea water.

Herr Diegel examines the conditions under which copper pipes on shipboard are corroded, and in view of the extensive use which is made of copper connections on modern vessels, this portion of his investigations are of especial importance.

Corrosion usually takes place in the inside of pipes, and an examination of pipes which have been in service reveals a variety of effects, thus complicating the determination of the causes. Thus in some cases there will be a general pitting over the whole interior surface, while in others the corrosion is confined to grooving and cutting in limited portions. Especially is this action found at points where the pipe has been highly heated for the purpose of brazing on flanges or other connections.

In general the causes of local corrosion in pipes may be sought among the following: namely, the use of a variety of kinds of copper in the original construction; the admittance of air into the interior of the pipes; or the production of electrolytic action.

A chemical analysis of the material of copper pipes which had been in service on a number of ships revealed the following facts: Pure copper is, in general, more rapidly corroded than metal which contains impurities, the ordinary commercial material being acted upon less rapidly than electrolytic copper. The presence of oxide in the copper increases its liability to corrosion. Apparently the presence of arsenic in the copper hastens the corrosive action.

So far as the action of air is concerned, it operates indirectly, by causing the formation of spots of oxide, creating galvanic couples, and thus promoting corrosion. The presence of arsenic in such cases appears to retard the corrosion.

Electrolytic corrosion, due to the action of stray electric currents, forms a most formidable clause for the weakening of copper pipes, and this should especially be guarded against on shipboard by having all return circuits carefully maintained.

The usual protection against the corrosion of copper pipes is the attachment of pieces of zinc, this metal taking the character of an anode to the copper, and itself being corroded by the galvanic action thus produced. This protective action would be best produced if the zinc could be placed in the form of an insulated rod running the entire length of the pipe, but this is hardly practicable in actual service. An objection to the use of zinc is found in the danger of excessive corrosion being produced at the points where the corroded particles of the metal fall upon the inner surface of the copper.

Herr Diegel appears to think that greater safety may be obtained by the use of certain alloys instead of attempting to employ ordinary copper pipes, and he has made numerous tests with different alloys of copper, nickel, zinc, and iron. In order to compare the value of the copper-nickel alloy, comparative trials were made with tin, iron, and aluminum bronzes, the copper-nickel alloys tested containing from 18 to 42 per cent. of nickel. Rods of the various metals were suspended in sea water for 25 months and tests being made before and after the immersion to effects of the water upon the strength were seen. Without going into the details of the tests, which are fully given, both in diagrams and tables in the original paper, the general result was favorable to the nickel copper alloy. The action of the water was distinctly affected by the other materials with which the nickel-copper alloy was associated, the nickel-copper being protected to a greater or less extent at the expense of its neighbors. Thus the iron-bronze was deeply corroded and the nickel-copper correspondingly protected, which similar actions to a less degree occurred in connection with the other bronzes.

Experiments were also made upon nickel-steel alloys, and the ill effects of placing ordinary steel castings in association with nickel-steel in contact with sea water was clearly shown. Similar effects were produced by the association of pieces of iron containing different percentages of phosphorus, the portion containing the lesser proportion of phosphorus forming the anode and being corroded, while at the same time protecting the portion containing the higher percentage of phosphorus.

RECENT EXPERIMENTS IN GLIDING FLIGHT.

LATER EXPERIENCES WITH SOARING AEROPLANES AND KITE MACHINES IN CONNECTION WITH HUMAN FLIGHT.

Wilbur Wright—Western Society of Engineers.

IT has been well said that a man might spend a lifetime in studying the equilibrium of forces in connection with riding a bicycle, and yet be no nearer the ability to ride at the end than he was at the beginning. It is more than probable that the same is true with regard to aerial navigation, and even with the aid of inflated gas bags for support the experiences of Santos-Dumont and others has demonstrated that proper balancing is a large element in success.

About two years ago we reviewed in these columns the experiments of the Wright Brothers in connection with gliding flight, and gave some account of the success which had been attained in the support of the human body by means of aeroplanes of improved construction, employing only the supporting power of air currents. We now have another paper, presented before the Western Society of Engineers by Mr. Wilbur Wright, and published in the *Journal* of the society, detailing later experiments in the same line, with much interesting practical information, showing the extent to which individual experience in balancing and automatic control enters into success.

The machine used by the Wrights consisted of a form of box kite, the latest model being a double-deck machine, having two surfaces, each 32 feet from tip to tip and 5 feet from front to rear.

The total area of the main surfaces was about 305 square feet and the front rudder added to this about 15 square feet, while the vertical tail was originally 12 square feet, afterwards reduced to 6 square feet. The weight of the entire machine was 116½ pounds, and including the operator the total weight sustained was from 250 to 260 pounds.

Mr. Wright describes a number of experiments which have been made with this machine, mainly in connection with soaring, the preliminary trials having been made with the apparatus as a kite, without an occupant, in order to determine the angle at which soaring could best be maintained. By soaring is meant not only that the weight of the machine is fully sustained, but also that the direction of the pressure upon the wings is such that the propelling and the retarding forces are exactly in balance. Under these conditions the resultant of all the pressures is exactly vertical, and there is no unbalanced horizontal component. The photographic illustrations to Mr. Wright's paper show this condition very clearly, with the machine floating in the air and the retaining ropes exactly vertical. This result was obtained with the wind at an upward trend of 7 degrees, and further experiments with an occupant in the apparatus followed. One of the peculiar features of the machine is that the operator does not occupy an upright position, but lies nearly flat upon the lower sail, experience having shown that there is less disturbance to the equilibrium of the machine in this position than in any other, while the control is readily secured.

After some rather peculiar experience involved in acquiring familiarity with the steering mechanism, the experimenters appear to have been remarkably successful in making numerous gliding flights, and even in high winds the apparatus behaved well. The principal feature which was developed was the necessity for prompt, almost instinctive action in responding to changes in the wind. By long practice the management of a flying machine should become as instinctive as the balancing movement which a man unconsciously makes with every step in walking. The necessity for acquiring this experience made the operators keep close to the ground in their early flights, and often a glide of several hundred feet was made and a distance of but a few feet from the ground.

As Mr. Wright says:

"Progress is slow in the preliminary stages, but when once it becomes possible to undertake continuous soaring advancement should be rapid. Under special conditions it is possible that this point is not so far away as might be supposed. Since soaring is merely gliding in a rising current, it would be easy to soar in front of any hill of suitable slope whenever the wind blew with sufficient force to furnish support, provided the wind were steady. But by reason of changes in the wind velocity there is more support at times than is needed, while at others there is too little, so that a considerable degree of skill, experience, and sound judgment is required in order to keep the machine exactly in the rising current."

The importance of these experiments can hardly be overestimated, when it is realized that they show clearly that success in aerial navigation involves other elements than merely a correct construction. They demonstrate beyond doubt that an aeroplane can support itself and an occupant in the air merely by the action of the wind operating at a small angle, but they also show that unless the greatest skill and experience is available for guidance and balancing, the mere fact of support is useless. Nearly every designer of a machine intended to fly assumes that if only he can make his apparatus self-supporting success is assured. The example of the bicycle may again be called in, if only to remind us that the fact that the machine is supported by the ground is but one element in the problem of successful control.

If balancing and guidance are of such importance in simple gliding, as in the case of the Wright experiments, how much more important do they become when a self-propelled machine is considered. Instead of depending upon the wind for the supporting power, such a machine must be able to make independent headway, this adding to the complications of air currents and their irregularities, combining the artificial motion of the machine with the natural movements of the wind. It would seem, in the light of our present information, that the art of aerial navigation would be best advanced by the devotion of time and money to the development of skill in balancing and guiding, following out the experiments of the Wrights and others upon larger and larger scales, and bringing up this most important element in the problem to a state which would enable it to be treated constructively with the same scientific skill which has been expended upon the construction of light motors and other details. Such work would be far more profitable than the more showy performances which have been made of late with dirigible balloons, and would have a greater effect upon final success. It has been suggested that the gas bag might well be employed in such experiments as a temporary means of support, while the necessary experience was being gained with the aeroplane, much in the same manner as an air belt is employed in teaching the art of swimming. By some such means the artificial support might be gradually diminished and finally omitted altogether.

ENGINEERING AND POPULATION.

THE USE AND MISUSE OF POPULATION STATISTICS AS SOURCES OF DATA FOR MUNICIPAL ENGINEERING WORK.

A. Prescott Folwell—Engineering Record.

IN preparing plans for important engineering undertakings it is most essential that every care be taken to secure reliable data upon which all the subsequent work must be based, and frequently it is in the selection and determination of the original data that the experience and judgment of the engineer appears in the highest degree. Among such sources of information the determination of present and future population appear as of great importance, and hence the article by Mr. A. Prescott Folwell in a recent issue of the *Engineering Record,* upon the use and misuse of population statistics demands consideration.

Civilized nations have long since realized the value of population statistics, and efforts have been made in recent years to have what was at first only a numbering of the people extended to include commercial, technical, and physical information. At the same time so much depends upon the intelligent and conscientious use of such statistics that deductions are almost valueless unless they are accompanied with information as to the manner in which the census data have been used. To quote a well-known saying: "Figures will not lie; but liars will figure."

Mr. Folwell gives full credit to the efforts which are made to obtain accuracy in the United States census reports, but, as he well says:

"Too often a misuse is made of even reliable data, through ignorance or carelessness; the fact that the data have government authority too often giving a false sense of the reliability of all calculations based upon them. Many, even among engineers, are deceived and in some cases self-deceived, by such misuse; and it seems desirable to call attention to some of the more common forms of errors in the use of population figures.

"A common example is presented by water consumption reports. In the great majority of cases the per capita consumption of a city is given as the quotient of the total consumption by the total population, and these figures are compared for different cities, no account being taken of the number of consumers; whereas to be of any, or at least of the most, use the consumption per actual consumer should be given."

In many large cities the resident population of the active business districts is very small in proportion to the number of daily occupants, but it is the latter population upon which the engineer must base his computations for water supply, sewage, street cleaning, and other public works. It is in such districts that the water supply per capita becomes most misleading, since the great bulk of the consumption is that of the population which does not enter into the divisor, and the figures become meaningless.

"Statistics relating to the density and growth of city populations are often misleading, since in most cases the area of a city at a given census either embraces rural population, or does not embrace all of the urban, and the true density and growth of the urban are therefore not given. The limits of many cities in the South Atlantic States are defined as 'the circumference of a circle drawn from the court house as a center with a radius of —— miles,' this often including hundreds of acres of farm land on one side and excluding scores of blocks of urban residences on another. New York City's density in 1890 was 58.87 per acre, in 1900 it was only 16.43, the reduction being due to annexation of sparsely settled territory meantime, and not to any considerable change in actual density of any given area."

Mr. Folwell, however, rightly considers existing problems of this sort as matters which should be determined by the engineer upon his own observation for each specific case, and proceeds to examine the larger problems connected with the provision for the future.

"It is not only the present population, whose numbers concern the engineer; but it is generally realized that for many purposes the future population must be estimated for ten, twenty or even fifty years. Examples of this necessity are found in designing sizes of sanitary sewers and of water mains, which should be ample for thirty or more years to come; in providing transportation facilities in large cities which shall be adequate for at least ten or twenty years; in determining upon the character of pavement to be laid (Kuichling has devised a formula in which the imperviousness of a pavement is made a function of density of population, in recognition of the fact that increase in such density is generally accompanied by increasing excellence of paving); and upon the size of blocks into which a given area is to be divided by streets, since densely populated and business districts should contain smaller blocks than should ordinary residence districts. In the majority of cases in the past such estimates of density as have been made have been upon the principle of "guessing at half and multiplying by two." Arbitrary predictions of 20, 40, 80, or similar numbers per acre are commonly made; in many instances the available funds are actually—sometimes confessedly—made the basis of size of water pipe or sewer, rather than the population. Such unscientific methods are unworthy of the profession when (as it is admitted is not always the case) any better ones are possible or practicable. Future population must generally be estimated from the present and its laws of growth in the past, with a consideration of the extent to which the laws of growth may be altered by future changes in economic or other conditions, and consequently past, present and future populations constitute one progressive problem."

For determining reliable ratios of past growth to use in predicting future requirements it is most desirable that the original data be carefully gathered and checked. This is only possible for the present data, but in some cases these results can be extended backward to check errors in past data by noting their variation from the present census information. Mr. Folwell gives formulas for use in such computations, and advocates the use of the method of differences as well as the plotting of curves in order to ascertain the probable future rate of increase.

In adition to all such mathematical methods the judgment of the engineer must enter into such predictions to a very large extent, since local influences, the beginnings of which may in some cases be already detected, may materially act to change the otherwise normal rate. The development of natural resources may act to increase the rate of growth to a degree which might otherwise be considered preposterous, while, on the contrary, the growth of business competition, changes in methods of production and manufacture, and the like, may cause a formerly prosperous and increasing place to be checked.

The whole subject is but another evidence of the broad scope of the work of the engineer, rendering him necessarily a sociologist and a close observer of nature and of civilization or of their close interrelation; a connection which it is the object of his profession to develop and increase.

THE HEAT TREATMENT OF STEEL.

RESTORATION OF DANGEROUSLY CRYSTALLINE STEEL TO ITS ORIGINAL PROPERTIES BY HEAT TREATMENT.

J. E. Stead and A. W. Richards—Iron and Steel Institute.

THERE is probably no one material of construction concerning which our notions have undergone more radical changes during the past few years than that most important substance known as steel. It is not so very long ago that the question was asked: "What is steel?" and even yet the question is but imperfectly answered. At least we know that it is a material of very varying properties, and that those properties by no means depend upon chemical composition alone, but that the physical structure may and does vary to a marked degree according to the heat treatment which the piece has undergone; and that the strength, toughness, and general usefulness of a structural member of steel may be largely controlled by the way in which it is subjected to the action of heat.

Formerly it was assumed that phosphorus gave brittleness, sulphur made the metal red-short, and that the other properties were almost entirely dependent upon the proportion of the carbon content. With the introduction of the microscope and the use of the methods of metallography in the study of steel and other alloys, it has been found that the structure and the properties of the material may be largely modified without any change whatever in the chemical composition, and as a consequence some very practical lessons have been learned.

In a paper presented before the recent meeting of the Iron and Steel Institute by Messrs. J. E. Stead and Arthur W. Richards, the great practical value of the study of the effects of heat treatment upon steel is shown, especially in connection with the restoration of toughness and strength to steel which has been rendered crystalline by overheating or other improper treatment.

It has been completely demonstrated by the researches of Brinell, Tschernoff, Le Chatelier, Heyn, Ridsdale, Stead, and many others, that when steel or a coarse structure, but not necessarily brittle, is heated to a certain temperature and is then allowed to cool in air, or is quenched in oil or water, the original structure is destroyed, and is replaced by one of a very fine character. As recently as 1898 Mr. Stead showed that pure iron, when so coarsely crystalline as to resemble cast zinc, was restored to excellent qualities simply by heating to the critical point, so that it resembled the same iron in the condition in which it left the rolls.

The extensive use of steel for important structures, such as railways, buildings, bridges, and the like, renders it most important that only the best of material in the best of condition should be used, and the dangerous nature of crystalline steel is recognised by all as unfit for such purposes. For several years Messrs. Stead and Richards have devoted much time and attention to the study of the effects of heat upon the mechanical properties of steel, and have repeatedly succeeded in restoring dangerously crystalline steel in large pieces by simple heat treatment, obtaining material which would be accepted by any engineer as excellent. In view of the success of these experiments the account which has been given in the paper referred to is of especial value and interest, and some abstract of the method is here given.

Dangerously crystalline steel may be divided into three classes:

"The first class occurs only in mild steel very low in carbon and in pure iron; it is caused by annealing for a long period at too low a temperature in a slightly oxidising atmosphere. The second class, which is equally dangerously crystalline and is very common, is produced by long continued heating at high temperatures. The third variety occasionally met with is produced by heating the steel till it is practically burnt. In other words, to a point so near fusion that an evolution of gas occurs in the interior of the steel which separates the crystals from each other, so breaking up or making more or less discontinuous the whole mass. The metal in the third class, although greatly improved by heat treatment, can never be thoroughly restored by simply heating it; but in the case of the steel of the first and second classes, no difficulty has been found, by proper heat treatment, in making it equal and more often superior to the normal or forged steel which had been worked and finished at proper temperatures."

The experiments which are examined in detail in the paper were made upon steel rails of various sections, portions of the same rail being tested in the normal condition, after overheating, after restoring, and after a still higher heating. The temperatures were in all cases carefully taken by pyrometer, and the material was also analysed, and subjected to microscopical examination. The tests to which the material was subjected included the impact or drop test, tensile test, Brinell impression test, and vibratory-stress test, and the records of these examinations, both for the specimens taken from rails and those from large ingots are given in detail in the paper. The results fully bear out the theory, and show that when the material was originally of good quality it was fully restored by proper heat treatment.

The most essential feature which appears about the method is the demonstration of the fact that it is the temperature to which has little or no influence upon the result. and not the duration of that temperature. The old idea of the process of annealing was that of reheating the material to a high temperature and holding it for a time at that temperature, and then causing it to cool very slowly, but the researches of Messrs. Stead and Richards show that the reheating must not exceed a temperature of about 900° C., and that the time of cooling has little or no influence upon the result Reheating and re-forging is an altogether unnecessary process, and, indeed, the material is very apt to be further injured by such a process. Since nearly any piece of structural steel is liable to be rendered more or less crystalline during the operations through which it is necessarily passed, it is most desirable that the process of restoration be made a regular portion of the routine of manufacture. To permit this it is only necessary that proper furnaces be designed to admit the large pieces and to permit a uniform temperature to be maintained in all parts, together with reliable pyrometers to enable the correct heat to be maintained, and the operation may be performed on every piece as the final stage in its manufacture. The result would be the complete elimination of danger or accident from weakness by crystallisation, thus removing the principal source of danger in modern metallic structures.

The following facts appear to have been fully established by the researches of Messrs. Stead and Richards:

"The microscope in each experimental series indicates the same result, that heating at high temperatures causes a great development in the size of the crystalline grains, and reheating to about 870 degrees restores the original or a better structure—see photographs C and D series.

"If all structural steels in their normal rolled or forged condition are good, they can be readily deteriorated in quality by heating to a temperature a little above that to which steel is most commonly heated previous to rolling or forging.

"Steel made brittle by such heating and dangerously brittle by heating at considerably higher temperatures can be completely restored to the best possible condition without forging down to a smaller size or by remelting.

"Practically all the results show that not only are the original good qualities of normally rolled steel, after making brittle, restored by the exceedingly simple treatment of heating to about 900 degrees C. for a very short time, but that such steel is made considerably better than it was."

WROUGHT IRON AND STEEL PIPE.

THE RELATIVE MERITS OF STEEL AND WROUGHT IRON AS MATERIALS FOR GAS AND WATER PIPE.

Engineering News.

ONE of the natural consequences of the concentration of administration, such as is constantly occurring by reason of the combination and consolidation of engineering and manufacturing industries, is the selection of certain materials and methods which show themselves to be adapted for general use, and the relegation of others to the background. In some cases this selection is naturally made for reasons connected with the economy of manufacture, either as related to economy of material or as dependent upon matters of mass production and the development of standard methods.

In a recent issue of *Engineering News* there appears a paper by Mr. Franklin Riffle, originally presented before the Pacific Coast Gas Association, upon the subject of commercial wrought iron and steel pipe, while in another portion of the same issue is a letter from Mr. John R. Freeman, the well-known hydraulic engineer, of Providence, R. I., discussing the same question from the point of view of the user; and both papers are of sufficient importance to be given more than passing notice.

The combination of the more important steel and iron works of the United States into one great corporation has been discussed in various manners, but there is one phase of the question which may well be mentioned in this connection. Formerly a customer ordered what he wanted, and if one manufacturer could not supply it another was found who would. In most cases the various users of material settled down to the dealers who suited them best as to products and prices, and differences arose but infrequently. With the consolidation of the various manufacturing establishments came a desire to abandon the smaller variations in sizes, styles, and qualities, with a continual effort to unify production along certain broad lines from which all customers could draw their supplies. The soundness of this principle, as a general proposition, must be conceded, provided always that the quality and character of the products adopted were placed and maintained at such a high standard of excellence as would commend themselves to the user, and warrant him in so modifying his practice as to admit the standard product in the place of that formerly employed.

The case in question at the present time is that of pipe for the conveyance of water and gas. The standard article for this service has been made of wrought iron to dimensions and grades which have been so well settled by usage as to be practically accepted as permanent. It now appears, however, that the manufacturers are producing large quantities of steel pipe, and according to Mr. Freeman, are supplying it instead of wrought iron pipe.

Mr. Riffle, in his paper, to which reference has been made above, discusses the question openly from the standpoint of the manufacturers, and shows the advantages of steel as a material for pipe, in a detailed and definite manner. After examining the earlier methods of making butt and lap welded pipe, and touching upon the questions of pipe joints and screw threads, he proceeds:

"The crowning achievements of the pipe industry has been the successful use of steel in the manufacture of wrought pipe. This innovation by one of the leading pipe mills in the early '80's, met with a storm of opposition, not only from rival mills, but from engineers as well.

"It was represented that a perfect weld could not be made with steel; that steel pipe could not be threaded, and that it was even more unreliable and treacherous when under pressure than cast-iron pipe. As late as ten years ago, many engineers refused to accept steel pipe as a substitute for wrought-iron pipe, although manufacturers were prepared then, as now, to prove its superiority. Since then engineers have so universally adapted themselves to the new conditions, that when an occasional nonconformist specifies wrought-iron pipe, in preference to steel, it is assumed that he has not kept pace with the wonderful progress that has been made in the manufacture of steel tubular goods during the last decade. At the present time manufacturers are producing a uniform quality of steel for pipes, that for malleability, ductility, and weldability, cannot be excelled by the more expensive product of the puddling furnace, while for tensile strength it is vastly superior to the highest grades of iron."

So far as the strength and the resistance of steel pipe to corrosion are concerned, Mr. Riffle refers to the experiments of Dr. H. M. Howe, which show the strength of the steel pipe to exceed that of wrought-iron pipe by amounts varying from 41 to 119 per cent., while so far as corrosion goes the tests made by Dr. Howe show that there is no appreciable difference between steel and wrought iron.

Mr. Riffle still further adopts the position of the manufacturers when he advises the user to leave the question of specification to the maker, either accepting the product without limitations, or selecting from among the maker's specifications that which most nearly meets his requirements. Thus he says:

"Engineers sometimes prepare elaborate specifications for pipe without stopping to consider if they are practicable. So far as the quality of the material and the details of manufacture are concerned, it is always advisable to conform to the practice of the best pipe mills. All grades of steel, for example, are not equally weldable, therefore it would be a waste of time to specify steel that could not be welded. It is always a good plan to obtain from some reputable mill such specifications as are best adapted to the work in hand. Arrangement can then be made to have the pipe made in accordance with these specifications under the supervision of a competent inspector."

All this is eminently satisfactory, if the manufacturer may be considered as such an altruistic party as to select always the best for the customer; but Mr. Freeman evidently has views of his own upon this point. Thus, after stating that steel pipe is supplied in filling order for wrought iron material, and that the steel pipe runs from 5 to 15 per cent. under the weight of standard wrought iron pipe of the specified dimensions, he goes on to say that the quality of material used in steel pipe is not of standard quality, but is skelp made of steelworks scrap, possessing none of the ordinary excellent qualities of mild steel as found in boiler plates and structural shapes. Under such circumstances Mr. Freeman suggests that further information is desirable upon the relative merits of iron and steel pipe, upon the relative strengths of existing pipe, upon the relative chemical composition of the material in steel pipe and that in structural steel and boiler plate, and upon the safe working strength of commercial pipe and fittings.

Accepting Mr. Freeman's position to the extent that it is most desirable that the truth in the matter be made public and that definite information concerning the vital points suggested be obtained, it may well be considered whether steel is not as superior to iron for pipe as it has been found superior to iron for other purposes. If the manufacturers put as good steel into pipe as they do into other products, and if every care is taken to insure toughness, perfect welds and general uniformity, there appears to be no good reason why steel should not be used, and many reasons why it should be favored.

At one time wrought iron rails were the rule, and steel rails the exception, but that day has long since passed, and wrought iron is no longer in the market for rails. The same transformation may be desirable for pipe, but the pipe must be proportionately as good as the rails, or the change cannot be expected to meet the approval of that careful and reliable class of engineers so well represented by Mr. Freeman.

ELECTROLYTIC COPPER REFINING.

EXPERIMENTAL DETERMINATION OF DATA OF COSTS AND OF ECONOMICAL OPERATIVE CONDITIONS.

W. D. Bancroft—American Electrochemical Society.

AMONG the papers presented at the recent meeting of the American Electrochemical Society at Niagara Falls was one by Mr. Wilder D. Bancroft, discussing the costs of the various operations involved in the electrolytic refining of copper, these results having been especially determined by experiments made for the purpose. In view of the value of the data we give some abstract of the paper, referring the reader to the original for the details.

"In determining the best conditions for the electrolytic refining of copper, we must consider the cost of the power necessary to precipitate a tank-full of copper under different current densities and at different temperatures; the cost of heating the tank; the deterioration of the electrolyte; the interest charge on the copper in the tank; the cost of pumping, and the quality of the copper deposited. Good adherent copper can be obtained at almost any current density, provided the rate of circulation be sufficient. The question of the cost of pumping has not been taken up, and is supposed to remain constant while the conditions are varied. The watt-hours necessary to precipitate a gramme of copper increase with increasing current density, and decrease with rising temperature. The cost of heating increases with rising temperature, and the interest charge on the copper in the tank decreases with increasing current density. With increasing current density, we have to strike a balance between the increasing power and the decreasing interest charge. With rising temperature, we have to strike a balance between the decreasing cost of power and the increasing cost of heating."

Tests were made to determine the variation of voltage with variations of temperature, current density, and solution, the standard solutions being used and also the effect of the addition of sodium chloride. In this way information was obtained as to the variations of current efficiency when operating with different electrolytic solutions at varying temperatures and different current densities, there being differences of opinion upon some of these points. The general opinion has been that current efficiency falls off rapidly when the temperature rises above 50° C., but the tests showed that the efficiencies diminished very little for temperatures below 70° C., and that even at a temperature of 90° C. the efficiency was more than 90 per cent.

The presence of iron in the electrolyte has been assumed to lower the current efficiency, but this was wholly disproved by the tests, and no iron was precipitated from the solution.

Since the temperature is an important element in the cost of the work a series of experiments were made to determine the cost of maintaining the electrolyte in the vat at the operating temperature. Experiments were made with a tank which could be heated by a platinum coil, and the losses at various working temperatures were measured. It was found that a material saving was made by covering the vat, and a table is given showing the losses both for covered and uncovered vats from which the effect in operation may be described.

It is evident that to operate at a temperature of 90° and a low-current density is entirely out of the question, not only on account of the cost of power to heat the solution and precipitate the copper, but also on account of the deterioration of solution, which takes place very rapidly under these conditions. At this high temperature and the higher current densities, the cost rapidly approaches a minimum, but here also the deterioration probably more than offsets the advantage of reduced cost of power. To operate at 20° C. is not so costly as would seem at first thought. The cost is maximum at the lowest and the highest current densities, reaching a minimum between two and one-quarter and two and one-half amp/qdm.

The conclusion is that the best result would be obtained at a temperature of 70°, with a current density between 3.5 and 3.75 amp/qdm, since at this density no extra power is required to heat the solution. Operating at this current density, and with the tanks covered, the current alone would be able to heat the electrolyte to over 80° C. In order to secure a good circulation, essential for a good deposit with high current density, the present method of pumping should be retained.

The lower the cost of heating, the greater the advantage of a high temperature. Lowering the rate of interest decreases the advantage of a high-current density. With covered tanks, it will be possible for men to work in the tank room even with the electrolyte at 70°.

If we compare the cost of working under so-called standard conditions of open tanks, a current density of fourteen amp/sq ft and a temperature of 50° with the cost of working with covered tanks at 70° and a current density of 3.5 amp/qdm (31.5 amp/sq ft), the saving by the latter method will be very close to a dollar a ton of refined copper when all power is figured at $20 per horse-power-year.

Therefore, in order to operate a plant most economically, copper should be refined electrolytically under these conditions:

1. Covered tanks.
2. Current density 3.5 amp/qdm.
3. Temperature 70°.

ELECTRIC AND STEAM TRACTION.

THE PROFITABLE RESULT OF THE INTRODUCTION OF ELECTRIC POWER ON THE MANHATTAN ELEVATED RAILROAD.

Electrical Review.

THE advantages of electric traction for surface tramways have been so fully demonstrated as to need no comment at this late date, but the relative economy of electricity and steam has, until recently, been rather a matter for deduction than certainty. The published results of the workings of the elevated railways in New York since their conversion from steam to electric driving, however, give definite figures upon which some very interesting comments are made in a recent issue of the *Electrical Review.*

For many years the Manhattan Elevated Railway had been successfully operated by steam locomotives. It carried its passengers with a certain degree of comfort and speed, handling numbers greater than any other similar corporation previously, and at the same time earned dividends for its stockholders. Ever since the development of electric transportation, projects and suggestions have been made to change the Manhattan from steam locomotives to electric distribution. A conservative management, backed up by reasonably satisfied and cautious stockholders, deferred the improvement until such time as the demands of the traffic exceeded the capacity of the plant when operated by steam locomotives.

Without giving the full tabulation of the comparative earnings of the elevated railroads in Manhattan for the quarter ending on June 30, 1903, and the corresponding quarter of the previous year, the following facts will suffice to show the advantage of the change from steam to electricity. The gross earnings during the three months showed an increase of $400,000, while the expenses were reduced $99,000, there being thus shown a gain to the profit account of about half a million dollars. The cost of carrying a passenger in 1902 is given as 2.24 cents, while with the electric traction this has been reduced to 1.98 cents.

The important consequence of all this appears in the substantial object lesson which has been given to the men who control steam traction on the great main-line railways. As is pointed out in the article referred to, the men who are interested in the elevated railway system in New York are also the individuals who control the destinies of the majority of the steam railroads of the United States. These men have naturally hesitated to consider anything leading to the conversion of the railways in which they are interested on the principle of let well enough alone. With the example of what has been done on the elevated railroad, however, they need not look to outside sources of information, but have the data entirely in their own hands.

The data furnished by the elevated railroads of New York, however, will need careful examination and digesting before the results can be made available for use in passing upon main-line service.

In the first place, the traffic is undoubtedly more intense on the Manhattan railway than on any other line in the world, so that there is the business upon which the difference can be shown. The entire length of the system is equal to about 100 miles of single track, while over this length of road about 800,000 passengers are carried daily. To draw conclusions from information derived from such conditions for application to systems over which a fraction of the business is done is liable to be misleading in the extreme.

At the same time, there is some indication of the possible transformation which such information may indicate in the conduct of main-line transport. The electrification of steam railways will undoubtedly begin with the local and suburban branches, and on these the density of traffic is sufficient to make a good showing. With increased speeds, such as have already been shown to be possible on the Berlin-Zossen military road, the range of local traffic will be extended, and what was formerly trunk-line business will find itself being conducted upon local methods, with continuous service of frequent small trains at close time-intervals, instead of the time-table method now in vogue. This alone will tend to increase the business, on the time-honored principle that facilities create traffic, and the suburbs of the great cities will be determined on a time basis instead of distance.

The requirements of municipal cleanliness and safety will soon compel all steam railways to use electric traction for their entrance to terminal stations, and the service of electric locomotives for such service will doubtless gradually extend out to near-by points, but with constantly increasing distances as the advantages make themselves apparent. It must be remembered that what were once the beginnings of the great trunk railway systems are now but their local sections, and the growth of electric traction as a substitute for steam locomotives may well follow the same method of development. The steam engines need not be scrapped until they meet their end in the natural order of things, but in the meantime the methods of replacement will have had time to become modified, so that the question of cost can be permitted to take care of itself. In the meantime the work of the example in New York will go on, and information as to the money-making capacity of electric traction be demonstrated.

THE ELECTRICAL SMELTING OF COPPER.

RESULTS OBTAINED WITH THE KELLER AND LELEUX FURNACE AT GRENOBLE IN THE DIRECT SMELTING OF COPPER BY ELECTRICITY.

Société des Ingénieurs Civils de France.

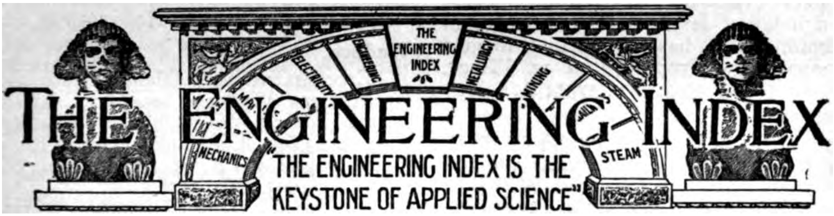
IN spite of the difficulties as regards cost compared with the use of ordinary fuels, engineers continue to make determined efforts to employ the electric current for the smelting of metals from their ores, and we have already chronicled in the columns a number of the plans which have been proposed and tried. Some of these efforts appear to give promise of practical success, and in a paper recently presented before the Société des Ingénieurs Civils de France, and published in the *Mémoires* of the society, M. Ch. Vattier gives an account of the work which has been done at Grenoble with the Keller and Leleux furnace for the electrical smelting of copper.

M. Vattier relates how, in the course of a visit to Chili, he brought to France a quantity of ores of copper, iron, and manganese for purposes of experiment, and after some preliminary trials at the works at La Praz, he made a careful trial with the furnace at Livet, near Grenoble. The result of these trials was so encouraging that proper modifications in the furnaces were made and plans for the further reduction of copper ores by electricity were arranged.

M. Vattier gives in his paper a report of a test made in the presence of a number of eminent English and French metallurgists, showing that 8,000 kilogrammes, or 8 metric tons, of ore were treated in the electric furnace and fully reduced to a matte in eight hours by the expenditure of 500 kilowatts of electrical energy. This ore contained about 7 per cent. of metallic copper, and the resulting matte showed 43 per cent. of metallic copper, while but 0.1 per cent. of metallic copper was found in the slag. The consumption of the carbon electrodes during the operation amounted to 6 to 7 kilogrammes per ton of ore treated, but by the use of electrodes of artificial graphite this consumption may be reduced to 5 kilogrammes per ton.

The furnace used is of a double type, there being an upper crucible in which the ore is fused in the arc formed between two electrodes, and a lower portion into which the fused material flows, this latter being provided with movable carbon electrodes which may be plunged into the molten bath or raised above the surface. By this arrangement the fusion is fully effected in the first crucible and the reduction finally effected in the second portion, the latter operation being capable of close regulation, the slag being drawn off above and the fused matte by separate openings lower down. The result of numerous experiments with this apparatus have shown that 100 tons of ore can be treated in 24 hours by the expenditure of 3,000 horse power, so that the cost of the operation may be determined by the cost of power in the locality where the work is done.

M. Vattier goes somewhat into detail into the matter of the cost of smelting the same ores in Chili, and shows that the question of the economical employment of electric energy for smelting over the use of coke furnaces is worthy of consideration in that locality. Thus, at the foot of the Cordilleras, where the "Volcan" mine from which the ores above referred to were taken, coke costs at least 100 francs per metric ton, while ample and uniform hydraulic power is readily and cheaply obtainable. The coke furnaces there in use consume 3,200 kilogrammes of coke per ton of copper produced in the form of matte, so that there is a cost of 320 francs per ton on the fuel account. The cost of electrical energy is estimated by M. Vattier as 30 francs per kilowatt year, or at 1.25 kilowatt per ton of copper produced, gives 38 francs for the cost of the current. The cost of electrodes is put at 45 francs, or a total of 83 francs as against 320 francs for the older process, all other charges being assumed to remain unchanged. The advantages of electrical smelting appear, but in a lesser degree, for poorer ores, and in any case the cost should be worked out according to the quantity of ore to be treated and the local conditions under which the work is done.



THE ENGINEERING INDEX

"THE ENGINEERING INDEX IS THE KEYSTONE OF APPLIED SCIENCE"

The following pages form a Descriptive index to the important articles of permanent value published currently in about two hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every article.

(1) The full title,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published.

We supply the articles themselves, if desired.

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer and works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of any article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the journals indexed are given.

DIVISIONS OF THE ENGINEERING INDEX.

CIVIL ENGINEERING 283
ELECTRICAL ENGINEERING 288
GAS WORKS ENGINEERING 294
INDUSTRIAL ECONOMY 295
MARINE AND NAVAL ENGINEERING..... 296
MECHANICAL ENGINEERING 297
MINING AND METALLURGY 304
RAILWAY ENGINEERING 309
STREET AND ELECTRIC RAILWAYS...... 311

CIVIL ENGINEERING

Concrete-Arch.

The 80-ft. Concrete-Arch Bridge Over the San Leandro Creek, San Leandro, Cal. William B. Barber. Illustrated description of a monolithic structure built entirely of concrete. No iron was used in the construction of any of the parts. 600 w. Eng News—Aug. 27, 1903. No. 57641.

Hinged Arch.

The Graphical Computations of Triple-Hinged Arch Bridge (Le Calcul Graphique des Ponts en Arc). M. Jacquier. A study of the distribution of forces in arches with hinges at the crown and springings, employing the method of lines of influence. 5000 w. 1 plate. Ann des Ponts et Chaussées—1 Trimestre—1903. No. 58044 E + F.

Loadings.

Loadings for Railroad Bridges. An informal discussion of the subject—"In view of the increasing weights of rolling stock, for what loadings should railroad bridges be designed?" 2400 w. Pro Am Soc of Civ Engrs—Aug., 1903. No. 57688 E.

Loadings for Railroad Bridges. Continued discussion. 800 w. Pro Am Soc of Civ Engrs—Sept., 1903. No. 58111 E.

Long Span.

Connel Ferry Railway Bridge. Illustrated detailed description of a bridge in Scotland, which has the second longest clear-span in Europe. 3300 w. Engr, Lond—Sept. 11, 1903. No. 57914 A.

Mississippi.

The Mississippi River Bridges. F. B. Maltby. An illustrated historical and descriptive sketch. 32000 w. Jour W Soc of Engrs—Aug., 1903. No. 57980 D.

New York.

Blackwell's Island Bridge. Perspective view of the bridge as it will appear when completed, with brief description and general information. 1000 w. Sci Am—Sept. 19, 1903. No. 57890.

The Blackwell's Island Bridge. Specifications for the material and workmanship for the superstructure, and engravings showing the plan and elevation of this bridge, with details. 1400 w. R R Gaz—Aug. 28, 1903. No. 57639.

Reconstruction.

The Reconstruction of the Frans Bridge (La Reconstruction du Pont de Frans). G. Canat. An account of the replacement of the suspension bridge over the Saone at Villefranche by a cantilever railway bridge. 6000 w. 2 plates. Ann des Ponts et Chaussées—1 Trimestre, 1903. No. 58046 E + F.

Reinforced Concrete.

Foot Bridge in Reinforced Concrete (Passerelle en Béton Armé). Col. G. Espitallier. Illustrated description of a bridge of 42 metres span on the Hennebique system over the Canal du Midi, at Toulouse. 1800 w. Génie Civil—Sept. 5, 1903. No. 58007 D.

Suspension.

Repairing the Williamsburg Bridge Cables. An illustrated article describing the very efficient repairs made to the cables injured by fire on this East River bridge at New York. 1200 w. Eng Rec—Sept. 5, 1903. No. 57789.

Swing Bridge.

New Swing Bridge Over the Amsterdam Canal. Gives an outline elevation and description of a new swing bridge, of very considerable span, at Velzen, Holland. 1000 w. Engr, Lond—Sept. 18, 1903. No. 58107 A.

Transporter Bridge.

A Great Ferry Bridge. Brief notes on bridges of this description at Martrou, and at Nantes, with illustrated description of one to be erected at Bordeaux, with a span of a quarter of a mile in length. 2000 w. Engr, Lond—Aug. 28, 1903. No. 57722 A.

Widnes and Runcorn Transporter Bridge. Illustrated description of this bridge and its operation. 2200 w. Prac Engr—Aug. 21, 1903. No. 57570 A.

Viaduct.

Erection of the Atlantic Avenue Improvement Viaduct, Brooklyn. An illustrated article describing the erection of about 13,600 ft. of steel viaduct to carry the Long Island R. R. 2700 w. Eng Rec—Sept. 5, 1903. No. 57788.

The Viaur Railway Bridge. J. Walter Pearse. Gives the history of the bridge, the general conditions, and an illustrated description of the structure and its erection. 6300 w. Fielden's Mag—Sept., 1903. No. 57966 B.

The Viaur Viaduct on the Railway Line from Carmaux to Rodez, France. M. René Bonnin. Illustrated detailed description of the work, with discussion of the principles and advantages of the design. 8500 w. Eng News—Sept. 10, 1903. No. 57821.

Weighbridge.

Combined Weighbridge for Weighing Mixed Trains. Brief illustrated description of weighbridges recently introduced for railway service at Birmingham, Eng. 500 w. Engng—Sept. 11, 1903. No. 57910 A.

Yellowstone Park.

Bridge Work in the Yellowstone Park. An illustrated article describing work carried on by the U. S. government. The work of placing concrete is carried on day and night without permitting the material to set before deposits are added. 1300 w. Ry & Engng Rev—Sept. 5, 1903. No. 57755.

CANALS, RIVERS AND HARBORS.

Back Water.

A New Method of Computing the Backwater Curve (Ein Neue Weg zur Berechnung der Staukurve). Dr. A. Fliegner. Developing equations enabling the curve to be computed for any relative fall. 2000 w. Schwerzerische Bauzeitung—Aug. 22, 1903. No. 58080 B.

Bavaria.

The Danube--Main Canal System (Die Donau-Main-Wasserstrasse). D. Lange. A review of the proposed development of the canal system of Bavaria. 2500 w. Glasers Annalen—Sept. 1, 1903. No. 58024 D.

Dams.

A Severe Flood Test of an Earth Dam at Newcastle, Pa. G. B. Zahniser. Illustrates this dam and describes its construction and the severe test due to an unusual storm. 800 w. Eng News—Sept. 24, 1903. No. 57956.

The Borings for the Bohio Dam for the Panama Canal. R. C. Smith. An illustrated article giving a brief description of the method of making these borings, the difficulties encountered, and the results obtained. Also discussion. 8000 w. Jour W Soc of Engrs—Aug., 1903. No. 57978 D.

Docks.

Dock Improvements at Liverpool. George Cecil Kenyon. Illustrates and describes works in progress in connection with the construction of new deep-water entrances at Brunswick dock. 11200 w. Pro Am Soc of Civ Engrs—Sept., 1903. No. 58110 E.

The New Graving Dock of the Kawasaki Dock Yard Co. at Kobe, Japan. Dr. Genjiro Yamasaki. An illustrated detailed description. 4500 w. Eng News—Sept. 24, 1903. No. 57955.

Dredge.

Bucket and Suction Dredge (Drague Marine Porteuse et à Refoulement). Ch. Dantin. Illustrated description of a sea-going dredge built for Tunis by Smulders of Rotterdam. 1500 w. 1 plate. Génie Civil—Aug. 29, 1903. No. 58004 D.

The Chaquette Pneumatic Dredge. An illustrated description of a power-clam-shell dredge, invented by Ehraiem Chaquette. 1000 w. R R Gaz—Sept. 11, 1903. No. 57827.

Floods.

Engineering Aspects of the Kansas Floods. Waddell & Hedrick. Brief outline of the damage with short descriptions of the bridges destroyed,—17 in all. Ill. 2400 w. Eng Rec—Sept. 12, 1903. No. 57880.

The Kansas City Flood of 1903. An illustrated description of the great flood, the damage done, etc. 2500 w. Eng News—Sept. 17, 1903. No. 57943.

Flow.

Methods of Measuring Velocity in River Channels. H. A. Pressey. Abstract from a monograph entitled "Observations on the Flow of Rivers," published by the U. S. Geol. Surv. Illustrates and describes methods of stream measurement. 3500 w. Sci Am Sup—Sept. 5, 1903. No. 57774.

Isthmian Canal.

Panama or Nicaragua? Editorial discussion of the attitude of the Columbian legislators, and of some of the advantages of the Nicaragua route. 2000 w. Eng News—Sept. 17, 1903. No. 57945.

The Republic of Colombia and the Panama Canal. John George Leigh. A handsomely illustrated account of the industrial and political conditions in the mainland state, showing the general character of the country as a whole. 4000 w. Engineering Magazine—Oct., 1903. No. 58081 B.

Levees.

The Levee Theory on the Mississippi River. An informal discussion of the subject—"In the treatment of the Mississippi River, is the levee theory justified by experience?" 21000 w. Pro Am Soc of Civ Engrs—Aug., 1903. No. 57689 E.

Light-houses.

Revolving Lanterns for Light-houses. Illustrates and describes three types of flashing lanterns, with remarks on the difficulty in making and properly mounting the lenses. 900 w. Sci Am—Sept. 26, 1903. No. 57958.

Navigation.

The Elements Constituting a Navigable Waterway (Des Elements Constitutifs d'une Voie Navigable). MM. Cadart et Barbet. A discussion of the relation of capacity to the frequency of travel upon canals and other internal waterways. 8000 w. 1 plate. Ann des Ponts et Chaussées —1 Trimestre, 1903. No. 58043 E + F.

The Ninth International Navigation Congress (IX Congrès International de Navigation). Report of the French Delegates to the congress held at Düsseldorf in 1902., with the general reports upon the various questions submitted to the congress. 40000 w. Ann des Ponts et Chaussées—1 Trimestre, 1903. No. 58042 E + F.

CONSTRUCTION.

Beams.

Deflections of Beams with Variable Moments of Inertia. Discussion of paper on this subject by C. W. Hudson, continued from May, 1903. 3800 w. Pro Am Soc of Civ Engrs—Aug., 1903. No. 57685 E.

The Flexure of Beams. An account of experiments given in a recent work by Albert E. Guy. 3500 w. Builder—Aug. 29, 1903. No. 57701 A.

Building Construction.

Structural Steel Work in the Macy Building, New York City. Illustrated detailed description of the framework of a recently built department store having nine stories, a basement and sub-basement. 2200 w. Eng Rec—Sept. 19, 1903. No. 57934.

Caissons.

Auxiliary Pneumatic Caisson Work for the Bank of the State of New York. An illustrated description of difficult foundation work in New York city, where the soil was sandy and very wet. After a large amount of work had been done on the building, the excavation was carried down 10 ft. farther. 2500 w. Eng Rec—Aug. 29, 1903. No. 57635.

Iron Framing.

Early Iron Building Construction. Illustrates and describes interesting details of floor framing in an old building in New York. 2700 w. Eng News—Sept. 10, 1903. No. 57820.

Retaining Walls.

Mistaken Ideas with Reference to the Resultant Force and the Maximum Pressure in Retaining Wall Calculations. J. S. D. Moffet. An explanatory illustration. 1300 w. Feilden's Mag—Sept., 1903. No. 57965 B.

Use of Mineral Oil in Road Improvement. James W. Abbott. From the year book of the U. S. Dept. of Agri. for 1902. A review of tests, benefits, objections, preparation, etc. Ill. 6800 w. Automobile—Sept. 5, 1903. No. 57742.

Roads.

Methods of Macadam Construction in Some New Jersey Towns. Describes the method used in northeastern New Jersey, discussing its merits. 1500 w. Eng News —Aug. 27, 1903. No. 57644.

Roofs.

Notes on Roofs and Roof Coverings. Especially considers suitable material for the roofs of mining and metallurgical works. 2000 w. Eng & Min Jour—Sept. 5, 1903. No. 57786.

Tunnels.

A New Tunnel at Genoa. An illustrated article describing interesting details of working adopted by reason of the difficult conditions under which the operations had to be carried out. 2400 w. Engr, Lond—Aug. 28, 1903. No. 57723 A.

The Simplon Tunnel (Simplon-Tunnel). The Nineteenth quarterly report, showing the progress made from April 1 to June 30, 1903. There is now about 77 per cent. of the total length completed. 2000 w. Schweizerische Bauzeitung—Aug. 15, 1903. No. 58079 B.

MATERIALS.

Cement.

Portland Cement Manufacture. Edwin C. Eckel. The present article deals with the preparation of dry materials for the kiln. 1500 w. Munic Engng—Sept., 1903. No. 57985 C.

Progress Report of Special Committee on Uniform Tests of Cement. Discussion of this report, by Sanford E. Thompson. 1700 w. Pro Am Soc of Civ Engrs—Aug., 1903. No. 57686 E.

The Fatigue of Cement Products. J. L. Van Ornum. States results of experiments made to determine the behavior of certain Portland cement mixtures when subjected to repeated loads of a less intensity than would produce failure when once applied. 700 w. Pro Am Soc of Civ Engrs—Aug., 1903. No. 57684 E.

Concrete.

Impervious Concrete. An informal discussion of the subject—"Is it possible to make concrete which will be impervious to water? If so, what is the best method?" 7000 w. Pro Am Soc of Civ Engrs—Aug., 1903. No. 57690 E.

The Uses of Concrete in Recent Engineering Practice. Samuel H. Lea. Read before the Scranton Engineers' Club. Considers the materials from which it is made and the purpose to which it has been applied. 4800 w. Mines & Min—Sept., 1903. No. 57596 C.

Concrete Mixing.

The Efficiency of Concrete Mixing Machines. Clarence Coleman. Reports investigations made to determine the comparative efficiency of these machines. Ill. 3200 w. Eng News—Aug. 27, 1903. No. 57646.

Explosives.

High Explosives; Safe and Economical Methods of Handling. J. H. Karkeet. Condensed paper, read before the L. Sup. Min. Inst. Notes the progress made in the manufacture and use of these explosives, their advantages, methods of handling, etc. 2500 w. Eng & Min Jour—Sept. 19, 1903. No. 57942.

Lime.

The Manufacture and Properties of Hydrate of Lime. S. Y. Brigham. Describes the method of manufacture, showing the results of comparative tests, and making a general comparison with the qualities of quick lime in the lump form. 1600 w. Eng News—Aug. 27, 1903. No. 57642.

Paints.

The Value of White Paints on Engineering Structures. Explains why white paint is not a permanent paint, both from a chemical and physical point of view. Considers also attempts that have been made to produce a permanent white lead pigment. 3500 w. Engr, Lond—Sept. 4, 1903. No. 57858 A.

Reinforced Concrete.

Test of a Reinforced Concrete Slab. Sanford E. Thompson. Describes a test made by the writer. 600 w. Eng Rec—Sept. 12, 1903. No. 57883.

Sand Cement.

Sand-Cement and Sand-Lime Brick. Paul. Tafel. Gives the early history of the industry. Considers it adapted to all kinds of building purposes. 1200 w. Munic Jour & Engr—Sept., 1903. Serial. 1st part. No. 57751 C.

Timber.

Timber Tests. An informal discussion. 18500 w. Pro Am Soc of Civ Engrs—Aug., 1903. No. 57687 E.

MEASUREMENT.

Surveying.

The Standard and Its Use in Surveying. Edward Riordan. Illustrated description, with remarks on its various uses. 1200 w. Eng News—Aug. 27, 1903. No. 57645.

MUNICIPAL.

Fire Prevention.

Fire Patrol Service for Dock Property. W. H. Hunter. Read before the International Fire-Prevention Congress. An account of the system of fire-preventive methods in operation at the docks of the Manchester Ship Canal. 4500 w. Engng—Aug. 21, 1903. No. 57583 A.

Pavements.

Brick Pavements. George W. Tillson. First of a series of four articles. Describes their origin and qualities, imperviousness to moisture, etc. 2800 w. Munic Jour & Engr—Sept., 1903. Serial, 1st part. No. 57749 C.

Wood Pavement in Greater New York. F. A. Kummer. An illustrated article describing methods of laying. 1500 w. Munic Jour & Engr—Sept., 1903. No. 57750 C.

Sewage.

On the Distributing of sewage on Bacteria Beds. John C. Thresh. Read before the Sanitary Inst. Discusses briefly the three methods in use, favoring distribution by sprinklers or sprays, at frequent intervals. 2000 w.. Engng—Aug. 21, 1903. No. 57584 A.

Sewage Purification. Informal discussion by Messrs. Rudolph Hering and George W. Rafter. 3400 w. Pro Am Soc of Civ Engrs—Sept., 1903. No. 58113 E.

Sewage Pumps.

Sewage Pumping Plant. Illustrated description of a triple-expansion, vertical sewage pumping engine, built for the Melbourne and Metropolitan Board of Works. 1600 w. Engr, Lond—Aug. 21, 1903. No. 57587 A.

Sewers.

A Large Concrete-Steel Sewer. Brief illustrated description of the Cleveland intercepting sewer, being built of concrete reinforced with steel rods. 1000 w. Eng Rec—Aug. 29, 1903. No. 57636.

Infiltration of Ground Water into Sewers. J. N. Hazlehurst. Shows the desirability and the difficulty of securing better joints, that infiltration may be reduced. Gives report of X. H. Goodnough bearing on this subject. 2500 w. Eng News—Aug. 27, 1903. No. 57643.

WATER SUPPLY.

Depreciation.

Depreciation. John W. Alvord. Examines in detail some of the features of water-works plants, and the conditions under which they depreciate. 3000 w. Fire & Water—Aug. 29, 1903. Serial. 1st part. No. 57655.

Filtration.

A Mechanical Filter Plant for the Ithaca Water Works Company. A statement of the conditions to be met and the past history of the water supply, with an illustrated description of the filtration plant near completion. 3400 w. Eng Rec—Aug. 29, 1903. No. 57634.

Automatic Modules for Regulating the Speed of Filtration. Continued discussion of paper by Charles Anthony, Jr. 2800 w. Pro Am Soc of Civ Engrs—Aug., 1903. No. 57691 E.

Filtration at Little Falls, N. J. An illustrated description of this new plant of the East Jersey Water Co., which successfully filters 32,000,000 gallons in twenty-four hours. 3000 w. Fire & Water—Sept. 12, 1903. No. 57866.

Filtration for Public Water Supplies, with Especial Reference to the Double Filtration Plant at Bremen, Germany. Eugen Goetze. An illustrated description of some of the characteristic features of the Bremen filter works. 5000 w. Pro Am Soc of Civ Engrs—Sept., 1903. No. 58109 E.

Lawrence Filter Division Walls. An illustrated description of the filter bed division walls at Lawrence, Mass. 1800 w. Fire & Water—Aug. 29, 1903. No. 57654.

The Sterilization and Filtration of Potable Water (Sterilisation et Filtration des Eaux d' Alimentatión). F. Gramyr. An illustrated account of the Desrumeaux system of mechanical filtration, employing alum as a coagulant. 3000 w. 1 plate. Revue Technique—July 25. 1903. No. 58040 D.

Irrigation.

Ancient Chaldean Irrigation. An illustrated article describing the ancient irrigation works of Chaldea, with a suggestion for their restoration. 3700 w. Builder—Sept. 19, 1903. No. 57986 A.

South African Irrigation. Francis Robert Johnson. An account of the use thus far made of irrigation, the methods and description of typical colonial furrows, as they are called. Also information of the geology, rainfall, water supply, crops, and related matters of interest. 8000 w. Pro Am Soc of Civ Engrs—Aug., 1903. No. 57682 E.

Reservoirs.

Reservoir Repairs at St. John, N. B. An illustrated description of the improvement of source of supply, increasing the reservoir capacity, and connected work. 1800 w. Fire & Water—Aug. 29, 1903. No. 57653.

Supplies.

Water Supply. Charles Hawkesley. From the presidential address to the Engng. Soc. of the British Assn. Considers the main features of water-works construction and management. 7000 w. Archt, Lond—Sept. 18, 1903. No. 57998 A.

Underground Supply.

The Geology and Underground Water Suply of South Lincolnshire. Henry Preston. Abstract of a paper read before the British Assn. of W-Wks. Engrs., with a summary of the discussion. Observations on wells and borings made and the relationship to their geological causes. 6000 w. Jour Gas Lgt—Sept. 15, 1903. No. 57906 A.

Water Waste.

Further Results of the Water Waste Investigations in New York City. A reprint of the third report, giving interesting results. 2400 w. Eng Rec—Sept. 19, 1903. No. 57936.

ELECTRICAL ENGINEERING

COMMUNICATION.

Automatic-System.

The Strowger Automatic Telephone System (Das Selbstanschluss System für Fernsprechämter von Strowger). H. Feyerabend. A fully illustrated description of the American automatic telephone system of Strowger, now being introduced into the German Post Office. 7000 w. Elektrotech Zeitschr—Sept. 3, 1903. No. 58066 B.

Cables.

Telephone Cables with Iron Wire Wrapping (Ueber Fernsprech Kabel mit Eisendrahtumwickelung). C. E. Walsöe. A discussion of the inductive effect of external iron wire wrapping upon telephone cables. 1800 w. Elektrotech Zeitschr—Sept. 10, 1903. No. 58070 B.

Two Simple Methods for Locating Faults in Cables. Edwin E. Northrup. Describes two methods of locating faults occurring on telephone lines. 1600 w. Elec Rev, N Y—Aug. 29, 1903. No. 57600.

Great Britain.

Government Telegraphs and Telephones in Great Britain. Calls attention to interesting statistics appearing in the last report of the British Postmaster-General. 1600 w. Elec Wld & Engr—Sept. 12, 1903. Serial. 1st part. No. 57884.

Pupin System.

Experiments upon the Pupin System of Long Distance Telephony (Untersuchungen über Telephonische Fernleitungen Pupinschen Systems). A review of the Siemens & Halske experiments upon the Pupin inductance coils in Germany. 2000 w. Glasers Annalen—Aug. 15, 1903. No. 58022 D.

Space Telegraphy.

Communication with Trains by Wireless Telegraphy. Describes the Guarini-Caesar system, which employs existing lines of telegraph wires. Ill. 1000 w. Sci Am—Sept. 26, 1903. No. 57960.

De Forest Wireless Telegraph on the Steam Yacht Erin. Illustrated detailed description of the installation and report of its working. 2000 w. Marine Engng—Sept., 1903. No. 57608 C.

Fessenden's Work in Wireless Telegraphy. A. Frederick Collins. Reviews Prof. Fessenden's work, noting the fundamental differences from other systems, and illustrating and describing some of the devices used. 2800 w. Elec Wld & Engr—Sept. 19, 1903. No. 57931.

Guarini's Wireless Fire Alarm Apparatus. Brief illustrated description of a device recently experimented with at Brussels. 600 w. Sci Am—Sept. 5, 1903. No. 57770.

Telegraphing by Electric Rays (La Télégraphie par Rayons Electriques). D. R. Blochmann. Describing experiments made with dielectric lenses for concentrating and directing the magnetic waves for space telegraphy. 1200 w. Rev Gendes Sciences—Aug. 15, 1903. No. 58050 D.

The Earth as a Condenser and Its Role in Wireless Telegraphy. Reviews a recent article in Dingler's *Polytechnische Journal* setting forth the views of Dr. A. Koepsel. 1800 w. Elec Wld & Engr—Aug. 29, 1903. No. 57604.

Telephone Station.

The New Telephone Station in Mannheim (Das Neue Fernprechamt in Mannheim). L. Dankwardt. A general description of one of the most recent telephone central stations in Germany, with details of the wiring and operation. 4500 w. Elektrotech Zeitschr—Sept. 10, 1903. No. 58069 B.

Telephony.

Some Features of Telephone Traffic and Their Effect on Service. J. G. Wray. 2800 w. Trans Am Inst of Elec Engrs—June and July, 1903. No. 57694 D.

DISTRIBUTION.

Conductors.

The Use of Aluminium as an Electrical Conductor. John B. C. Kershaw. Read before the British Assn. A record of experimental observations to ascertain the resistance to corrosion offered by commercial aluminium rod and wire. 2000 w. Elec Rev, Lond—Sept. 18, 1903. No. 57994 A.

Joints.

Electric Welded Joints. William Pestell. An illustrated article describing the work as carried out by the Johnson Co. and their successor. 2800 w. St Ry Rev (Daily Ed)—Sept. 5, 1903. No. 57807 C.

Rotary Converters.

Operation of Rotary Converters. W. T. Fernandez. Considers the operation and control of rotary converters operating in their natural capacity. Ill. 2200 w. Am Elect'n—Sept., 1903. No. 57780.

The Construction and Use of Rotary Converters in America (Bau und Betrieb von Drehumformern in Amerika). E. Alexanderson. With diagrams showing the practice of the General Electric Company. 2500 w. Elektrotech Zeitschr—Sept. 10, 1903. No. 58067 B.

Transformer.

A New Type of Transformer (Eine Neue Transformatorentype). E. Ziehl. Illustrated description of the Schwartzkopff transformer in which the core is arranged in a series of rectangles. 1200 w. Elektrotech Zeitschr—Sept. 10, 1903. No. 58068 B.

See also Street and Electric Railways.

ELECTRO-CHEMISTRY.

Acker Process.

The Acker Process for Alkali and Bleaching Powder by the Electrolysis of Fused Common Salt. Report of the Committee on Science and the Arts, of the Franklin Inst. Ill. 900 w. Jour Fr Inst—Sept., 1903. No. 57977 D.

Anodes.

Electrolysis at Smooth and Platinized Platinum Anodes. Prof. F. Foerster. Explains the difference in the behavior of smooth and platinized anodes at which no oxygen is evolved. 6500 w. Electro-Chem Ind—Sept., 1903. No. 57744 C.

Bleaching.

Electrolytic Production of Bleaching Liquor. W. H. Walker. Reviews the development of bleaching liquors, the apparatus used, and the systems that have had extensive trial. 3000 w. Electro-Chem Ind—Sept., 1903. No. 57740 C.

Electric Smelting.

Experiments in the Electric Smelting of Copper (Expériences Industrielles Electro-Metallurgiques pour la Fonte de Mineraio de Cuivre). Ch. Vattier. Describing experiments made on a large scale in smelting copper ores by the electric furnace at Livet, near Grenoble, with data as to costs. 5000 w. Mem Soc Ing Civ de France—July, 1903. No. 58026 G.

ELECTRO-PHYSICS.

Alternating Currents.

A Discussion of Some Points in Alternating Current Theory. W. S. Franklin. Discusses polar coördinate vs. clock-diagram method; necessity of choosing signs in complicated networks; etc. 4800 w. Trans Am Inst of Elec Engrs—June and July, 1903. No. 57693 D.

Electromagnets.

Powerful Electromagnets. Emile Guarini. An illustrated article showing the remarkable results obtained by M. De Mare. 700 w. Elect'n, Lond—Aug. 28, 1903. No. 57713 A.

Hysteresis.

Losses from Dielectric Hysteresis and the Capacity of High Pressure Machines (Ueber den Dielektrischen Hysteresisverlust und die Kapacität von Hochspannungsmaschinen). Dr. Paul Holitscher. An experimental investigation of the losses under high electric stresses in the micanite insulating tubes of motors and generators. 5000 w. Elektrotech Zeitschr—Aug. 13, 1903. No. 58055 B.

The Influence of the Distribution of Lines of Force in an Iron Ring upon the Losses by Hysteresis and Eddy Currents (Der Einfluss der Kraftlinienverteilung in einem Eisenringe auf die Verluste durch Hysteresis und Wirbelstrome). Rudolf Richter. A mathematical study of a general case, developing formulas and curves capable of application to generator and motor design. 4000 w. Elektrotech Zeitschr—Sept. 3, 1903. No. 58064 B.

Magnetism.

Terrestrial Magnetism in Its Relation to Geography. Capt. Ettrick W. Creak. Abstract of a presidential address to the Geog. Sec. of the British Assn. Reviews the work that has been done in the study of the earth's magnetism, and discusses magnetic changes, and work needing to be done in this field. 5400 w. Elect'n, Lond—Sept. 18, 1903. No. 57997 A.

Metals.

The Optical and Electrical Properties of Metals (Die Optischen und Elektrischen

Eigenschaften der Metalle). Dr. H. Rubens. A study of the relation of the optical and electrical properties of metals in connection with the reflection and absorption of luminous and Becquerel rays. 7500 w. Zeitschr d Ver Deutscher Ing—Sept. 12, 1903. No. 58018 D.

Radioactivity.

A Simple Method of Showing the Great Penetrating Powers of Certain Radium Rays. T. P. Black. An account of experimental investigations, with results. 900 w. Elect'n, Lond—Aug. 21, 1903. No. 57577 A.

Charles Vernon Boys Presidential Address to the Mathematical and Physical Section of the British Association. Outlines the properties of radium and points out the resemblance between radio-active phenomena and the origin and behavior of comets' tails. 8500 w. Engng—Sept. 18, 1903. No. 58105 A.

On Polonium and the Inducing Character of Radium. F. Giesel, in *Berichte d. Deutsch. Chem. Gesell.* An account of experimental investigations. 1000 w. Sci Am Sup—Aug. 29, 1903. No. 57616.

Radio-Activity and Chemistry. George F. Barker. An address delivered before the Chem. Soc. of Columbia Univ. An interesting review of investigations of radioactive substances, especially the recent work of Prof. and Madame Curie. Also the effects of the chemical action of these rays. Ill. 7500 w. Sch of Mines Qr—April, 1903. No. 57970 D.

The Radium Emanations. An editorial review of what has thus far been learned in regard to radium and like substances, and the investigations in progress. 3300 w. Engng—Aug. 28, 1903. No. 57727 A.

GENERATING STATIONS

Alternating Currents.

Some Effects of Armature Reaction in Alternating Current Machinery. W. M. Thornton. An acount of investigations, with diagrams. 2600 w. Elect'n, Lond—Sept. 4, 1903. No. 57844 A.

The Elementary Principles of Alternating Currents of Electricity. Prof. Tell. Aims to give a simple explanation. 2400 w. Engr, U S A—Sept. 15, 1903. Serial. 1st part. No. 57926 C.

The Production and Distribution of Alternating Current for Large City Systems. Richard McCulloch. Considers the production and transmission of alternating current, and the relative advantages of alternating and direct current transmission. Ill. 8800 w. St Ry Rev (Daily Ed)—Sept. 5, 1903. No. 57806 C. .

The Parallel Working of Alternators. B. Hopkinson. Read before the British Assn. An attempt to co-ordinate the mathematical treatment of the subject with the practical rules which are now regarded as good practice, and to point out the reason for certain observed phenomena. 5000 w. Elect'n, Lond—Sept. 18, 1903. No. 57996 A.

Auxiliary Plant.

Comparison Between Steam and Electrically-Driven Auxiliary Plant in Central Stations. C. D. Taite and R. S. Downe. Abstract of a paper read before the Manchester Soc. of the Inst. of Elec. Engrs. 2000 w. Elect'n, Lond—Aug. 21, 1903. No. 57580 A.

Breakdowns.

Breakdowns of Electrical Machinery. Michael Longridge. Abstract from the annual report giving particulars of the nature of breakdowns. Gives list of selected cases. 5700 w. Mech Engr—Sept. 19, 1903. No. 57991 A.

Continuous Current.

Some Notes on the Design of Magnet Systems for Continuous-Current Machines. Introductory notes to a discussion of the mechanical design of the magnet system are given in the present article. Ill. 1600 w. Elec Engr, Lond—Sept. 11, 1903. Serial. 1st part. No. 57900 A.

Dresden.

Combined Lighting and Heating Plant at Dresden. Illustrated description of an interesting installation having a common boiler plant for electricity supply and artificial heating by steam with long distance distribution. 2000 w. Elec Engr, Lond—Aug. 28, 1903. No. 57710 A.

Dynamo Design.

A Basis for the Comparison of Dynamo Designs. H. M. Hobart. Explains the suggested method. 1200 w. Elect'n, Lond—Sept. 11, 1903. No. 57903 A.

Notes on the Design of Continuous-Current Machines (Beitrag für den Entwurf von Gieischstrommaschinen). E. Dick. Developing equations for the computations of the proportions of parts, speed, weight, and other elements of continuous-current dynamos and motors. 2000 w. Zeitschr f Elektrotechnik—Aug. 16, 1903. No. 58076 D.

Hot-Water.

Hot-Water Heating in a Coal Country. Alton D. Adams. Illustrated description of the extensive system installed by the Miami Light, Heat and Power Co., of Piqua, O., for hot-water heating from an electric lighting station. 3300 w. Eng Rec—Sept. 19, 1903. No. 57933.

Hydro-Electric Stations.

Hudson River Water Power Co. Brief illustrated description of developments at Spier Falls, Mechanicsville and elsewhere on the Upper Hudson. 3500 w. St Ry Rev—Aug. 20, 1903. No. 57624 C.

Spier Falls Dam and Power Plant. Walter H. Main. Illustrations. with brief description. 700 w. Sci Am—Sept. 12, 1903. No. 57816.

The Congress of the "Houille Blanche." Marcel Bloch. Deals briefly with the technical propositions and ideas set forth by this congress for the development of the hydraulic power from the melting snows of the French Alps. 2300 w. Elec Rev, Lond—Sept. 4, 1903. Serial. 1st part. No. 57841 A.

The Water Power Plant of the Columbia Mills Company, Columbia, S. C. An illustrated article considering the interesting features of this plant. 1500 w. Eng Rec—Aug. 29, 1903. No. 57633.

Ithaca, N. Y.

The Ithaca, N. Y., Electric System. An illustrated description of a very unusual system. 5300 w. Engr, U. S. A.—Sept. 15, 1903. No. 57924 C.

Railway Plant.

Power Plant of the Pittsburg, McKeesport and Connellsville Railway. Illustrated detailed description of a plant of 6,000 kilowatts capacity, built to operate a system of electric railways and furnish electric current for lighting and power. 4000 w. Eng Rec—Sept. 5, 1903. No. 57787.

Station Practice.

Electrical Station Practice. W. H. Radcliffe. The first of a series of articles aiming to prove of special value to dynamo tenders, station engineers, and all interested in the construction, equipment and management of these plants. 2000 w. Elec, N Y—Sept. 9, 1903. Serial. 1st part. No. 57792.

Storage Batteries.

The Practical Storage Battery Operation. H. P. Liversidge. Suggestions helpful in securing successful operation, showing that intelligent care is all that is needed. 5000 w. Am Elect'n—Sept., 1903. No. 57782.

Supply Works.

The Financial Improvement of Electricity Supply Works. Joseph A. Jeckell. Abstract of a paper before the Incor. Munic. Elec. Assn. Outlines the principles to be considered, showing how they were applied at Coventry, and the result. 4000 w. Elect'n, Lond—Aug. 21, 1903. No. 57581 A.

Switches.

The Evolution of the Starting Switch. Discusses the essential requirements of a satisfactory starting switch. 1600 w. Elec Engr, Lond—Sept. 4, 1903. No. 57840 A.

LIGHTING.

Nernst Lamp.

Light and Illumination. E. Leavenworth Elliott. An illustrated article explaining the principle and tracing the development of the Nernst lamp. 2500 w. Cent Sta—Sept., 1903. No. 57793.

Train Lighting.

See Railway Engineering, Motive Power and Equipment.

MEASUREMENT.

Angular Variation.

A New Method of Determining the Angular Variation of a Rotating System (Neue Methode zur Bestimmung der Winkelabweichung eines Rotierenden Systems). Joseph Sartori. A discussion of the angular variation of alternators operated in parallel, discussing the stroboscopic and other methods of measurement. 1800 w. Zeitschr f Elektrotechnik—Aug. 23, 1903. No. 58077 D.

Cables.

The Measurement of Cable Capacity. An extract from a chapter in Vol. II, of "A Handbook for the Electrical Laboratory and Testing Room," by Dr. J. A. Fleming. 2000 w. Elect'n, Lond—Sept. 11, 1903. No. 57904 A.

Meters.

Electric Meters. Caryl D. Haskins. Discussing their relation to the earning power of electric light companies. 2200 w. Cassier's Mag—Sept., 1903. No. 57938 B.

Motor Losses.

The Measurement and Separation of Losses in Nonsynchronous Polyphase Motors (Messung und Trennung der Verluste bei Asynchronen Drehstrommotoren). W. Peukert. Discussing experiments for measuring separately the hysteresis and friction losses in polyphase motors. 2000 w. Elektrotech Zeitschr—Aug. 20, 1903. No. 58058 B.

The Separation of the Friction Losses in Electrical Machines. Dr. Leo Fenzi. Translated from the *Elektrotechnische Zeitschrift*. Gives methods for determining the air friction and bearing friction. 800 w. Elec Engr, Lond—Aug. 28, 1903. No. 57711 A.

Ohm Meter.

A Direct Reading Ohm Meter (Ein Direkt Zeigendes Ohmmeter). Dr. H. Sack. An ampere meter is kept at zero by the current from a storage battery, and the introduction of the resistance to be measured causes a proportional deflection. 2500 w. Elektrotech Zeitschr—Aug. 20, 1903. No. 58059 B.

Oscillograph.

A Simple Oscillograph (Ein Einfacher Oscillograph). A. Wehnelt. Describing a form of double magnet mirror galvanometer in which the oscillating deflections are proportional to the periodical variations of the current. The record is made on a moving band of photographic paper. 1200 w. Elektrotech Zeitschr—Aug. 27, 1903. No. 58062 B.

Speed Indicator.

The Dettmar Electric Speed Indicator. An illustrated description of an electric tachymeter for measuring the speed of vehicles that have a rectilinear motion, such as cars, automobiles, etc. 1400 w. Sci Am Sup—Sept. 12, 1903. No. 57819.

Power Measurement.

Measurement of Power in Alternating Current Circuits. Nathaniel R. Craighill. A description of the wattmeter method. 1500 w. Am Elect'n—Sept., 1903. No. 57781.

Measuring the Power of Machine Tools. George E. Walsh. A study of the power required by electrically driven machine tools. 1800 w. Am Elect'n—Sept., 1903. No. 57778.

Standards.

Explanations of the Standards for Classifying and Testing Electrical Machinery (Fläuterungen zu den Normalien für die Bewertung und Prüfung Elektrischer Maschinen und Transformatoren). G. Dettmar. A discussion of the standards of the *Verband Deutscher Elektrotechniker* for electric motors, generators and transformers. 1800 w. Elektrotech Zeitschr—Aug. 20, 1903. No. 58057 B.

Testing.

Shop Testing of Motors and Generators for Commercial Service. Bertrand B. Abry. Considers the usual shop tests as applied to new designs of direct and alternating current motors and generators. 1500 w. Elec Rev, N Y—Sept. 19, 1903. Serial. 1st part. No. 57928.

Voltmeters.

On the Use of Capacities as Multipliers in Connection with Electrostatic Voltmeters on Alternating-Current Circuits. Prof. E. W. Marchant and G. W. Worrall. Read before the British Assn. Describes experiments directed to the construction of a simple apparatus by which low-reading electrostatic voltmeters may be employed on circuits of much higher tension. 800 w. Elec Engr, Lond—Sept. 18, 1903. No. 57993 A.

Wattmeter.

The Electrostatic Wattmeter: Its Calibration and Adaptation for Polyphase Measurements. G. L. Addenbrooke. Explanatory notes on the use of this instrument. 2800 w. Elect'n Lond—Sept. 4, 1903. Serial. 1st part. No. 57843 A.

POWER APPLICATION.

Accumulators.

The Use of the Accumulator in Mining (Der Akkumulator im Bergbau). J. L. Huber. With illustrations of the extent to which the storage battery may be employed to equalize the load upon the generators in the supply of electrical energy for mining operations. 3000 w. Glückauf —Aug. 8, 1903. No. 58071 B.

Agriculture.

Electricity on the Farm. Emile Guarini. Illustrates and describes various agricultural machines worked by electricity. 1500 w. Elec Rev, Lond—Sept. 11, 1903. No. 57901 A.

The Present State of Electricity in Agriculture (Etat Actuel du Labourage Electrique). E. Guarini. A review of the applications of electric power to agricultural operations, with illustrations of ploughs, thrashing machines, trucks, etc. 2500 w. Génie Civil—Aug. 22, 1903. No. 58000 D.

Brake Magnets.

The Construction of Tubular Magnets for Brakes (Beitrag zur Konstruktion von Mantelmagneten für Bremszwecke). R. Hellmund. A discussion of the form and winding of tubular magnets for the construction of solenoid brakes. 4000 w. Elektrotech Zeitschr—Sept. 3, 1903. No. 58065 B.

Coal Cutting.

Electric Coal-Mining Plants. S. B. Belden. Shows the process by which they have been developed to meet the various requirements in different seams of coal. 3200 w. Mines & Min—Sept., 1903. No. 57592 C.

Electric Coal-Cutting. W. Walker. Abstract of a paper read at the Nottingham meeting of the Inst. of Min. Engrs. Gives experience with coal-cutting machinery in the hard coal at Digby Colliery and the New London collieries. Discussion. 2800 w. Col Guard—Sept. 18, 1903. Serial. 1st part. No. 57999 A.

Coal Handling.

Coal Handling Machinery Driven by Electric Motors. D. A. Willey. Illustrates and describes the plant recently installed at Sparrow's Point, Md. 1200 w. Elec Rev, N Y—Sept. 19, 1903. No. 57929.

Compensation.

On Compensation of Asynchronous Motors. H. S. Meyer. Discusses the pros and cons of the question of compensating and compounding alternating-current machines. 2400 w. Elect'n, Lond—Sept. 4, 1903. No. 57842 A.

Cranes.

Improvements in Electrically Operated Forge Cranes (Neuerungen an Elektrisch Betriebeucn Schmiede-Kranen). E. Becker. With details of bridge, trolley, and hoisting gear, together with special forms of blocks and chain connections. 3000 w. Zeitschr d Ver Deutscher Ing—Sept. 5, 1903. No. 58017 D.

Electric Drill.

An Ingenious Portable Electric Drill. Brief illustrated description of a portable electric drill, suitable for all descriptions of engineering work. 600 w. Sci Am Sup—Sept. 5, 1903. No. 57773.

Electric Drill for Boring Up-Hill in Mine Galleries. From *Revue Technologique*. Illustrated description. Col Guard —Sept. 11, 1903. No. 57908 A.

Electric Motors.

Electric Motors: Their Theory and Construction. H. M. Hobart. The first article of a second series, investigating the conditions leading to the most satisfactory design of polyphase motors. Ill. 6800 w. Trac & Trans—Sept., 1903. Serial. 1st part. No. 57851 E.

Elevators.

The Otis Elevator Company's Electric Elevator for Private Residences. Report of the Committee on Science and the Arts, of the Franklin Inst. 1200 w. Jour Fr Inst—Sept., 1903. No. 57976 D.

Fire Alarm.

Electro-Telethermometer of Juan Vila Forns. Brief illustrated description of a device for automatically announcing at any distance an elevation of temperature in its vicinity. 400 w. Sci Am—Sept. 12, 1903. No. 57815.

The Siemens and Halske Fire Alarms. Illustrated description. 1500 w. Sci Am Sup—Sept. 19, 1903. No. 57892.

Induction Motors.

A Graphical Analytical Investigation of the Single Phase Induction Motor (Der Einphasige Induktionsmotor in Grapishch Analytischer Darstellung). J. K. Sumec. An extension of the method of Görges with simplification of the expressions and application of graphical diagrams. 2000 w. Zeitschr f Elektrotechnik—Sept. 6, 1903. No. 58078 D.

A New Single-Phase Motor. L. Schüler, in *Elektrotechnische Zeitschrift*. An illustrated description of an alternating current motor working on the rotary-field and the repulsion principle. Ill. 3000 w. Elec Engr, Lond—Sept. 4, 1903. No. 57839 A.

The Induction Motor and Its Engineering Capabilities. George L. Hoxie. A thesis presented for the degree of Doctor of Philosophy. Gives a detailed study of a particular motor and of the behavior of the magnetic circuit in the present number. Ill. 6800 w. Jour Fr Inst—Sept., 1903. Serial. 1st part. No. 57975 D.

The Theory of Non-Synchronous Single Phase Motors (Zur Theorie des Asynchronen Einphasenmotors). Fritz Emde. A mathematical discussion of the theory of Görges, transforming the relations to render them applicable to the case of two rotating fields. 2000 w. Elektrotech Zeitschr—Aug. 27, 1903. No. 58061 B.

Live Rolls.

Electrically Driven Live Rolls (Ein Elektrisch Betriebener Blockrollgang). F. Janssen. Illustrating the operation of a set of live rolls for rolling mill feed by means of electric group driving with details and diagrams of operation. 1800 w. Stahl u Eisen—Sept. 1, 1903. No. 58033 D.

Machine Driving.

The Electric Drive as Applied to Machine Tools, with Special Reference to Railroad Shops. C. H. Hines. Outlines briefly what has been chosen as the equipment of a large railroad shop in the United States. 1600 w. Elec Wld & Engr—Sept. 19, 1903. No. 57930.

Mines.

Electricity in Mines. T. Campbell Futers. Discusses the details of the application of electricity to mine work, the causes of dissatisfaction and the remedies. Ill. 1600 w. Elec Rev, Lond—Aug. 21, 1903. Serial. 1st part. No. 57574 A.

Motor Losses.

See Electrical Engineering, Measurement.

Niagara Falls.

Developments at Niagara Falls for the Utilization of Its Power. An illustrated article reviewing the progress being made on both sides of the river. 2800 w. Elec Rev, N Y—Sept. 12, 1903. No. 57879.

Pumping.

Electric Motors for Centrifugal Pumps and Fans. Aug. J. Bowie, Jr. Study of the problem of determining the proper capacity of a motor in the case of centrifugal pumps and fans. 2300 w. Trans Am Inst of Elec Engrs—Sept., 1903. No. 57969 D.

Repair Shops.

Electricity in Railroad Repair Shops. An illustrated description of buildings of monolithic concrete construction and the electrical equipment of the Central Railroad Shops at Elizabethport, New Jersey. 2800 w. Am Elect'n—Sept., 1903. No. 57777.

Speed Control.

Electrical and Mechanical Methods of

Variable Speed Control. William Cooper. Abstract of paper read at Chicago meeting of the Nat. Elec. Lgt. Assn. Explains the various methods and devices used, comparing the electrical and mechanical methods. 5600 w. Ir Trd Rev—Sept. 10, 1903. No. 57867.

The Regulation of Polyphase Motors (Regulierung von Drehstrommotoren). Walter Burkard. A discussion of the various methods of regulating the speed of polyphase motors, with especial reference to a special form of motor composed of multiple elements capable of having the connections changed. 2500 w. Elektrotech Zeitschr—Aug. 27, 1903. No. 58060 B.

TRANSMISSION.

Converters.

Compound Wound vs. Shunt Converters. P. M. Lincoln. Discusses the advantages and disadvantages of the compound wound as compared with the shunt rotary. 2500 w. St Ry Jour—Aug. 29, 1903. No. 57678 C.

Notes on the Theory and Working of Rotary Converters. W. Rogers explains the characteristics, the methods of working, etc., and considers the advantages and disadvantages of the rotary converter as a transformer for alternating and continuous currents. Diagrams. 3500 w. Elec Engr, Lond—Sept. 11, 1903. No. 57899 A.

High-Pressure.

An Efficient High-Pressure Water-Power Transmission Plant. George A. Henry, Jr., and Joseph N. Le Conte. An illustrated article describing an interesting hydraulic plant in Southern California, used for transmitting power to Los Angeles, and for irrigation pumping in the San Gabriel Valley. 3000 w. Trans Am Inst Elec Engrs—Sept., 1903. No. 57967 D

Protective Devices for High-Tension Electrical Systems. W. B. Woodhouse. Read before the British Assn. Discusses several points in connection with the operation of a high-tension polyphase transmission system. Ill. 2700 w. Elec Engr, Lond—Sept. 18, 1903. No. 57992 A.

Regulation.

Regulation of Transmitted Power. Alton D. Adams. Considers the work of regulation in transmission systems. 3300 w. Elec Rev, N. Y.—Sept. 12, 1903. No. 57878.

MISCELLANY.

Lecture.

Electricity and Matter. Sir Oliver Lodge. A lecture delivered at Bedford College for Women. 3800 w. Sci Am Sup—Sept. 26, 1903. No. 57963.

Report.

The German Electrotechnical Society (Verband Deutscher Elektrotechniker). Report of the annual meeting, with regulations for standard installtion details, together with the discussions. Two articles. 30,000 w. Elektrotech Zeitscher—Aug. 13, 20, 1903. No. 58056. Each B.

GAS WORKS ENGINEERING

Carbon Monoxide.

On Some Details of the Estimation of Carbon Monoxide. Charles R. C. Tichbourne. Lecture before the Irish Assn. of Gas Mgrs. Describes the making of the solution and the method of working. 2000 w. Gas Wld—Aug. 22, 1903. No. 57567 A.

Cheaper Gas.

The Need of Cheaper Gas. C. E. Jones. A review of the gas industry, the questions of present importance and the future outlook. 3500 w. Jour Gas Lgt—Sept. 1, 1903. No. 57797 A.

Conveying.

The Mechanical Conveying of Coal and Coke. Emile Guarini. Illustrates and describes the apparatus installed by the Paris Gas Co. 1100 w. Sci Am Sup—Sept. 12, 1903. Serial. First part. No. 57817.

Croydon.

The Croydon Gas Works. Their Present and Past. Plan of extensions, with description and historical notes. 3300 w Jour Gas Lgt—Sept. 1, 1903. No. 57796 A.

Extensions.

Extensions at the Evesham Gas-Works. R. J. Milbourne. An illustrated description of a purifying installation; the chief novelty consisting in the fact that there are no connections or external valves in the ordinary sense of the term. 1800 w. Jour Gas Lgt—Aug. 18, 1903. No. 57568 A.

Gaseous Fuel.

Notes on the Production and Characteristics of Gaseous Fuel. B. H. Thwaite. Describes a gasifying system. 1800 w Engr, U S A—Sept. 15, 1903. Serial. First part. No. 57925 C.

Gas Works.

Steel Building Construction in Gas-Works. Samuel Cutler, Jr. Refers particularly to buildings for inclined retort benches and carburetted water gas plants, discussing the use of corrugated sheeting, and giving illustrated descriptions of various buildings. Also discussion. 7000 w. Gas Wld—Sept. 19, 1903. No 57989 A.

Incandescence.

Incandescent Gas Lighting (L'Incandescence par le Gaz). Ch. Féry. A study of the conditions required for successful gas lighting by incandescent mantles, with an examination of the theory. 1500 w. Génie Civil—Aug. 8, 1903. No. 58019 D.

Variations in the Lighting Power in the Incandescent Burner of Combustible Gases. E. Sainte-Claire Deville. Abstract translation of a paper presented to the International Photometric Committee. A discussion of the photometry of the gas and of the mantle and the subject of incandescent lighting in general. 3700 w. Jour Gas Lgt—Aug. 25, 1903. Serial. First part. No. 57705 A.

Natural Gas.

Notes on the Occurrence of Natural Gas at Heatsfield, Sussex. H. B. Woodward. Abstract from the Memoirs of the Geol. Surv., giving information concerning their deposits. 1500 w. Ir & Coal Trds Rev—Aug. 28, 1903. No. 57730 A.

Purification.

Notes on Gas Purification. Dr. H. Bunte. Abstract translation of a reprint in the *Jour. für Gasbeleuchtung* of a lecture delivered before the German Assn. of Gas & Water Engrs. 1700 w. Jour Gas Lgt—Sept. 15, 1903. Serial. First part. No. 57905 A.

Slot-Meters.

Slot-Meter Agreements. J. Duncan. Reviews English law and practice with regard to slot-meter agreements, giving a model. 5300 w. Gas Wld—Sept. 5, 1903. No. 57833 A.

Sulphur.

The Relation of Sulphur in Lighting Gas to Air Vitiation. J. S. Haldane. Reprinted from the *Jour. of Hygiene*. Concludes that unpleasantness of air vitiated by lighting gas is due to sulphur, and that gas purified from carbon bisulphide is greatly superior from the hygienic standpoint to gas which is only purified from sulphuretted hydrogen. 2700 w. Jour Gas Lgt—Sept. 1, 1903. No. 57798 A.

Testing Still.

The Testing Coal Tar and Oils and an Improved Testing Still. H. W. Jayne, in *Jour. Am. Chem. Soc.* Describes this still and the methods used. 1200 w. Am Gas Lgt Jour—Sept. 7, 1903. No. 57743.

Waste.

Unaccounted for Gas. Jno. Paterson. Read before the Irish Assn. of Gas Mgrs. Gives the writer's methods by which he brought the leakage down from 17 to 3½ per cent. General discussion. 4200 w. Gas Wld—Aug. 22, 1903. No. 57566 A.

Water Gas.

The Extension of Coal Gas Works by Use of Water Gas Plants (Die Erueiterung von Kohlen gaswerken durch Wassergasanlagen). Franz Walter. A description of the extent to which existing illuminating gas plants may be increased in capacity by the addition of water gas apparatus; with a description of the plant at Reichenberg, Bohemia. 3500 w. Zeistchr d Oesterr Ing u Arch Ver—Sept. 11, 1903. No. 58039 D.

INDUSTRIAL ECONOMY

Apprenticeship.

Apprenticeship in Engineering Training. Prof. John Dewar Cormack. A discussion of the best training and the conditions that should be fulfilled. 1800 w. R R Gaz—Sept. 11, 1903. No. 57828.

British Iron Trade.

The Future of the British Iron Trade as Affected by Pending Tariff Proposals. A discussion of the present situation and future outlook. 12800 w. Ir & Coal Trds Rev—Sept. 4, 1903. No. 57865 A.

Cost System.

A Shop Cost System. Lin. Wood. Describes a system for finding and keeping the shop cost of work produced, which may be applied to almost any shop. 1400 w. Am Mach—Aug. 27, 1903. No. 57606.

Methods of Calculation in Machine Construction (Ueber Kalkulations-Methoden in Maschinenbau). Sigm. Stephan Récsei. A discussion of the fundamental methods of computing factory costs in machine building, deriving formulas, and comparing methods of wages, depreciation, inventory, etc. Two articles. 8000 w. Zeitschr d Oesterr Ing u Arch Ver—Aug. 7, 14, 1903. No. 58037 each D.

Education.

College or Apprenticeship. Louis H.

Ransome. A consideration of the two systems of training, with a view to seeing in what direction improvements should be sought. 2000 w. Engr, Lond—Aug. 21, 1903. No. 57585 A.

Labor.

The American Negro for South America. D. H. Newland. Discusses the question of introducing negro labor from the United States. The investigations made do not recommend the negro as an efficient laborer. 2000 w. Eng & Min Jour—Aug. 29, 1903. No. 57627.

Labor Management.

The Issues Between Labor and Capital. Egbert P. Watson. An impartial discussion of the faults of trade unionism and the mistakes of employers. 3000 w. Engineering Magazine—Oct., 1903. No. 58086 B.

Premium System.

Experience with the Premium and Piece-Work Systems. R. J. Sutton. Discusses the attitude of labor organizations. 2400 w. Ir Trd Rev—Sept. 3, 1903. No. 57752 C.

The Premium System of Wages (Das Prämiensystem der Lohnberechnung). B. Schiller. A scientific examination of the Halsey premium system in comparison with day wages, also considering the Rowan modification and a method of the writer, together with piece work. 7500 w. Zeitschr d Ver Deutscher Ing—Aug. 22, 1903. No. 58014 D.

Unskilled Labor.

Famine Works in India. E. O. Mawson. An explanation of the system generally adopted for the management of these large camps of unskilled laborers. Ill. 3500 w. Engr, Lond—Aug. 28, 1903 No. 57718 A.

Waste.

The Utilization of Waste. Editorial calling attention to some cases where success has been attained and discussing the causes of some failures. 2400 w. Engng —Aug. 28, 1903. No. 57728 A.

MARINE AND NAVAL ENGINEERING

Battleships.

Size and Character of American Battleships. George W. Melville, in *American Industries*. Shows that decreasing the size of battleships is not desirable. 2400 w. Marine Rev—Sept. 3, 1903. No. 57734.

Cruisers.

Steam Trials of H. M. S. "Cumberland." Reports satisfactory results of official trials on the Firth of Clyde. 600 w. Engng—Sept. 11, 1903. No. 57911 A.

Ferryboat.

Ellis Island Ferryboat. An illustrated detailed description of a new boat for special service. 1800 w. Marine Engng—Sept., 1903. No. 57610 C.

Fire Boats.

The Evolution of the Fire Boat. An illustrated article showing the development in the United States. 2000 w. Fire & Water—Sept. 5, 1903. No. 57735.

Liners.

Three New Liners. Illustrations with brief descriptions of three vessels for the South Africa route. The Arundel Castle, Cluny Castle, and the Miltiades. 1400 w. Engr, Lond—Aug. 21, 1903. No. 57588 A.

Race.

Motor Boat Race. Paris-Rouen-Trouville. An illustrated article giving an account of the race. 1300 w. Auto Jour—Sept. 5, 1903. No. 57835 A.

Ship Yard.

Fore River Ship and Engine Works, Quincy Mass. Illustrations, with description, of cranes and the fixed structure in use. A separate rapid crane of small capacity is provided for each side of each ship. 1200 w. Engng—Sept. 11, 1903 No. 57909 A.

Speed Trial.

Remarkable Run of the Kearsarge Across the Atlantic. An account of the run of the U. S. battleship "Kearsarge" from Portsmouth, Eng., to the coast of Maine, covering 2,885 nautical miles in 219 hours, 30 minutes. Ill. 1100 w. Marine Engng—Sept., 1903. No. 57611 C.

Stability.

The Stability of a Modern Steamship with a Leak in the Starboard Engine Room (Untersuchung über die Stabilität eines modernen Schnelldampfers beim Leckwerden des Severbord-Maschinenraumes). Matthias Esser. A graphical analysis of the stability of a twin-screw steamship when one engine room is filled with water. Serial. Part 1. 2000 w Schiffbau—Aug. 23, 1903. No. 58034 D.

Towboat.

Steel Towboat Sprague. Illustration, with description of the largest towboat ever built for the Mississippi river. To be used in taking the immense fleets of coal barges down the river. 3800 w. Marine Engng—Sept., 1903. No. 57612 C.

Yachts.

Development of the 90-Foot Racing Yacht. Traces briefly the development that has taken place during the half-century of yacht racing contests. Ill. 2000 w. Sci Am—Aug. 29, 1903. No. 57615.

Efficiency at Sea. William W. Bates. Discusses the scientific design of racing yachts, and points having a bearing on the carriage, speed and efficiency of vessels 1800 w. Naut Gaz—Sept. 17, 1903. No. 57920.

Stern-Wheel Steam Yacht Fortuna. An illustrated description of a boat which embodies the advantages of the house-boat and also permits of navigating shallow streams at a good speed. 1000 w. Marine Engng—Sept., 1903. No. 57609 C.

The "Shamrock"-"Reliance" Races of 1903. Illustrations, with account of the first two finished races. 1400 w. Sci Am —Sept. 5, 1903. No. 57771.

Turbine Yachts at the International Races. Illustrations, with brief notes. 900 w. Sci Am—Sept. 5, 1903. No. 57769

MECHANICAL ENGINEERING

Competition.

The Deauville 500-Meter Competition. An illustrated account of the contest. 800 w. Auto Jour—Sept. 19, 1903. No. 57988 A.

Fuels.

Fuels for Motor Cars. The first of a series of articles introducing a discussion of suitable fuels. 1300 w. Autocar—Sept. 5, 1903. Serial. 1st part. No. 57837 A.

Heavy Oils.

The Problem of Heavy Oil for Automobile Engines. A letter on "Kerosene for Explosion Engines," with editorial comments. 3300 w. Auto Jour—Aug. 29, 1903. No. 57697 A.

Motor.

A Great Traction Motor. Brief illustrated description of a tractor used in Michigan for hauling logs during the winter season. 1000 w. Rev of Revs—Sept. 1903. No. 57692 C.

Motor Cars.

The Gobron-Brillié Cars. Illustrates and describes these cars in which balanced petrol engines are used. 3200 w. Auto Jour—Sept. 12, 1903. Serial. 1st part No. 57897 A.

The Wolseley Motor Car. Alex. Richardson. Illustrated detailed description of a typical car manufactured in Birmingham, Eng., and the making. 4800 w. Trac & Trans—Sept., 1903. No. 57849 E.

Motor Cycles.

The Tourist Motor Cycle 1,000 Miles Reliability Trials. An illustrated account of these trials in England. 800 w. Auto Jour—Aug. 22, 1903. No. 57569 A.

Motor Traction.

A New System of Motor Traction. A. W. Brightmore. Describes the writer's work in this field and the vehicle which is the final outcome. The front wheels are the driving wheels and also the steering. Ill. 5000 w. Mech Engr—Sept. 5, 1903. No. 57838 A.

Petrol Cars.

The Dennis Petrol Cars. An illustrated detailed description, calling attention to their leading characteristics. 2500 w. Auto Jour—Aug. 29, 1903. No. 57695 A.

Speed Gear.

The Newman-Gradually-Variable Speed Gear. Illustrated description of a change-speed gear which gives any speed from zero up to a certain limit. 1400 w. Auto Jour—Sept. 12, 1903. Serial. 1st part. No. 57898 A.

Steam Lurry.

The Savage Steam Lurry. Illustrated detailed description. 1700 w. Auto Jour —Sept. 5, 1903. No. 57836 A.

Steering.

Automobile Steering Mechanism. Brief illustrated descriptions of devices now used. 1600 w. Automobile—Sept. 19, 1903. No. 57918.

HYDRAULICS.

Centrifugal Pumps.

Theory of Centrifugal Pumps and Fans. Analysis of their action, with suggestions for designs. Discussion of the paper by Elmo G. Harris. 2500 w. Pro Am Soc of Civ Engrs—Sept., 1903. No. 58114 E.

Electric Pumping.

See Electrical Engineering, Power Applications.

Flow.

An Experimental Study of the Resistances to the Flow of Water in Pipes. Discussion of the paper by Augustus V. Saph, and Ernest W. Schoder, Jr. 3800 w. Pro Am Soc of Civ Engrs—Sept., 1903. No 58112 E.

House Drainage.

The Inefficiency of Modern House Drainage. William R. Purchase. Discusses the defects of stone-ware pipe, and considers needed improvements. 1400 w Builder—Sept. 19, 1903. No. 57987 A.

Pump Formulas.

Rules and Formulas for Steam Pumps and Water Pipes. C. A. Collett. Reviews the rules for finding the velocity of flowing water, the weight and pressure of columns of water of various heights, and deduces formulae, illustrating by examples. 3500 w. Engr, U.S.A.—Sept. 1, 1903. No. 57776 C.

Pumps.

Some Pump Troubles, Their Causes and Remedies. L. S. Rrainard. Considers troubles with steam pumps. Ill. 1800 w. Power—Sept., 1903. No. 57650 C.

Units.

A Suggested Hydraulic Unit. Ralph L. Montague. Suggests that a new unit composed of one cubic foot of water per minute under one foot head be recognized. 300 w. Trans Am Inst of Elec Engrs—Sept., 1903. No. 57968 D.

MACHINE WORKS AND FOUNDRIES.

Brass Melting.

Melting Rates in Brass Foundries. John F. Buchanan. A discussion of the best fuels, methods, the melting ratio, &c. 1700 w. Foundry—Sept., 1903. No. 57982.

Camming.

Directions for Camming the Brown & Sharpe Automatic Screw Machine. R. E. Flanders. 4800 w. Ill. Mach, N. Y.—Sept., 1903. No. 57662 C.

Case-Hardening.

Case-Hardening. A. W. McCaslin. Read before the Nat. R. R. Blacksmith's Assn. Explains the meaning of the term and the methods used, best material, &c. 1700 w. Am Mach—Sept. 10, 1903. No. 57809.

Castings.

Manufacture of Sound Castings by Means of Thermit. J. B. Nau. Reviews statements made by W. Mathesius, in the Aug. 15 issue of ***Stahl und Eisen***, with which the writer fails to agree. 3300 w. Ir Age—Sept. 10, 1903. No. 57766.

The Use of Thermite for the Production of Sound Castings and Forgings (Herstellung von Poren und Lunkenfreiem Grauguss, Stahlguss, und Schmiedestücken durch Anwendung von Thermit). W. Mathesius. Describing the methods of using a mixture of aluminum and iron oxide for effecting complete fusion and the production of steel and iron castings without blow holes. 2500 w. Stahl u Eisen—Aug. 15, 1903. No. 58030 D.

Cranes.

See Electrical Engineering, Power Applications.

Dies.

A Nice Job in Bending and Forming. Joseph V. Woodworth. Illustrated description of dies and work. 600 w. Am Mach—Sept. 3, 1903. No. 57761.

Die Work for Medals, Jewelry, and Art Goods. Joseph V. Woodworth. Describes methods used. 2300 w. Am Mach—Aug. 27, 1903. No. 57607.

Electric Driving.

See Electrical Engineering, Power Applications.

Foundries.

The Continuous Operation of the Iron Foundry. John C. Knocppel. Read at meeting of the Am. Found. Assn. Considers features that should be considered before deciding upon continuous operation. 2000 w. Foundry—Sept., 1903. No. 57-981.

Grinding.

Emery Wheel Practice in Foundries. Charles G. Smith. Read before the Pittsburg Foundrymen's Assn. Discusses conditions needed to secure good results, and points of importance in grinding. 3000 w. Ir Age—Sept. 10, 1903. No. 57767.

Gripping Tongs.

Rolling Mill Dogs. Ulrich Peters. Illustrates and describes types of gripping tongs, or automatic methods of gripping. 1100 w. Am Mach—Sept. 24, 1903. No. 57952.

Hardening.

A few Points in Hardening. E. R. Markham. Suggestions for treatment 700 w. Am Mach—Sept. 24, 1903. No. 57953.

Lathe Fixtures.

Some simple Lathe Fixtures. William Doran. Illustrates and describes devices for rapid handling and machining duplicate parts in the lathe, miller, and drill press. 700 w. Am Mach—Sept. 3, 1903. No. 57762.

Locomotive Works.

The Darlington Works of Robert Stephenson and Co. The first of a series of articles giving the history and detailed description of these works. 3000 w. Engr, Lond—Sept. 11, 1903. Serial. 1st part. No. 57913 A.

Metallurgical Engineers.

The Metallurgical Engineer in the Foundry. Henry Souther. Read at meeting of the Am. Found. Assn. Considers his value and discusses some objections made to such service. 1800 w. Foundry—Sept., 1903. No. 57984.

Molding.

Machine and Floor Plate Molding. C. Neil. An illustrated description of this type of molding. 1700 w. Am Mach—Sept. 17, 1903. No. 57871.

Piston-Rings.

Cast Iron for Piston-Rings. C. H. Wingfield. Read before the British Assn. Considers the permanent set in cast iron due to small stresses, and its bearing on the design of piston-rings and springs. Ill. 2500 w. Engng—Sept. 18, 1903. No. 58102 A.

Records.

Pratt's Record Scroll. Horace L. Arnold. Illustrates and describes this scroll, and states its advantages. 1400 w. Am Mach—Sept. 17, 1903. No. 57872.

Rolling Mill.

Universal Triple Rolling Mill (Universal Trio Walzwerk). Illustrated description of a powerful vertical triple rolling mill built at the Sack Machine Works near Düsseldorf. 1800 w. 1 plate. Stahl u Eisen—Aug. 15, 1903. No. 58031 D.

Rolls.

The Calibration of Rolls (Walzenkalibrierung). A. Sattmann. A discussion of the correct form and dimensions to be given to the passes in rolling-mill rolls for special shapes. 3000 w. Stahl u Eisen—Sept. 1, 1903. No. 58032 D.

Scrap.

Sorting Scrap Iron. Walter J. May. Hints on the sorting and use of this material. 700 w. Prac Engr—Sept. 18, 1903 No. 57990 A.

Screw Threads.

Casting Fine Threads in Gray Iron. John Randol. An illustrated description of interesting work. 1800 w. Am Mach—Sept. 3, 1903. No. 57764.

Shops.

A Model Bridge and Construction Shop. An illustrated detailed description of the Pennsylvania Steel Company's new plant at Steelton, Pa. The finest bridge shop in the United States. 3500 w. Ir Age—Sept. 10, 1903. No. 57765.

Machine Shop Equipment. Oscar E. Perrigo. The present article considers planning the different departments, suggesting the proper selection and arrangement of machines. 3700 w. Ill. Mach, N. Y.—Sept., 1903. Serial. 1st part. No. 57663 C.

The Inland Steel Company's Indiana Harbor Works. Illustrated detailed description of these works and their equipment. 2000 w. Ir Age—Sept. 3, 1903. No. 57667.

The Nuremberg Shops of the Nuremberg and Augsburg Machine Works (Das Neue Werk der Vereinigte Maschinenfabrik Augsburg und Maschinenbaugesellschaft Nürnberg A. G.). A fully illustrated description of the new shops at Nuremberg belonging to the great Augsburg combination. Three articles, three plates. 9000 w. Zeitschr d Ver Deutscher Ing—Aug. 22, 29, Sept. 12, 1903. No. 58013 each D.

The Reconstructed Shop of the Betts Machine Co. Illustrated detailed description. 2300 w. Mach, N. Y.—Sept., 1903. No. 57665 C.

Steep Pipes.

The Manufacture of Weldless Steel Pipes and Shells. Heinrich Ehrhardt. Read before the Iron & Steel Inst. An illustrated description of the process. 900 w. Ir Age—Sept. 17, 1903. No. 57869.

Wheels.

Making a Wheelbarrow Wheel. John Randol. Illustrated detailed description of the work as carried on in an Ohio shop. 2200 w. Am Mach—Sept. 3, 1903. No. 57760.

MATERIALS OF CONSTRUCTION.

Alloys.

Alloys of Copper and Magnesium (Les Alliages de Cuivre et de Magnesium). O. Boudouard. A microscopic study with micro-photographs of polished and etched surfaces of various alloys of copper and magnesium. 2000 w. Bull Soc d'Encour—Aug., 1903. No. 58035 G.

Alloys of Iron and Tungsten. R. A. Hadfield. Read before the Iron & Steel Inst. Abstract of the first part of this important paper, with the complete second part. A report of researches. 4000 w. Engng—Sept. 14, 1903. Serial. 1st part. No. 57855 A.

Corrosion.

The Influence of Sea Water on Copper and Copper Alloys (Einwirkung des Seewassers auf Kupfer und einige Kupferlegierungen). H. Diegel. Data and results of experiments upon the corrosion of copper sheets and pipes. 3500 w. Glasers Annalen—Sept. 1, 1903. No. 58023 D.

Inspection.

The Inspection of Materials. Part first considers the need and aim of inspections and whether good work is assured by the present system. 3700 w. Engr, Lond—Sept. 4, 1903. Serial. 1st part. No. 57857 A.

The Inspection of Rails. C. W. Gennet, Jr. A discussion of the inspector's duties.

2000 w. R R Gaz—Aug. 28, 1903. No. 57640.

Metallography.

The Utilization of Microscopic Metallography as a Method of Testing (La Métallographie Microscopique et son Utilisation comme Méthode d' Essais). Léon Guillet. A study of the practical applications of the methods of metallography to the determination of the quality of materials of construction. 10000 w. 1 plate. Mem Soc Ing Civ de France—July, 1903. No. 58027 G.

Metal Protection.

Lacquers and Paints for Metals. The first of a series of articles on compounds for protection or embellishment of metallic surfaces, and the proper way of applying them. 3000 w. Engr, Lond—Sept. 11, 1903. Serial. 1st part. No. 57915 A.

Metals.

The Physical Properties of Metals (Die Physikalischen Eigenschaften der Metalle). J. Traube. A comparison of the properties of metals according to the conditional equations of Van der Waals. 2000 w. Zeitschr d Ver Deutscher Ing—Aug. 15, 1903. No. 58012 D.

Nickel Steel.

Recent Researches on Nickel Steels (Nouvelles Recherches sur les Aciers au Nickel). Léon Guillet. Developing a diagram from which the properties of a steel may be predicted from a knowledge of the nickel and carbon content. 2500 w. Bull Soc d' Encour—Aug., 1903. No. 58036 G.

The Theory of Nickel Steels (A Propos de la Théorie des Aciers au Nickel). L. Dumas. A review of the theory recently set forth by Guillaume, showing its incompleteness and suggesting further extension of the allotropic theory to alloys of nickel and steel. 2000 w. Rev Gen des Sciences—Aug. 15, 1903. No. 58051 D.

The Theory of Nickel Steels (Contribution à la Theorie des Aciers au Nickel). F. Osmond. A review of the theory of Guillaume, agreeing in general with the application of the allotropic theory to the phenomena exhibited by nickel steels, and adding the results of further experiments upon the magnetic properties of the various alloys. 3000 w. Rev Gen des Sciences—Aug. 30, 1903. No. 58052 D.

Pig Iron.

See Mining and Metallurgy, Iron and Steel.

Steel.

See Mining and Metallurgy Iron and Steel.

Tool Steel.

Comparative Trials of High Speed Steels. Gompei Kuwadi. Describes trials and gives results. 1200 w. Am Mach—Sept. 3, 1903. No. 57763.

Rapid Tool Steels. Editorial on the recent improvements in tool steels, the tests made and what they show. 2700 w. Engng—Aug. 21, 1903. No. 57582 A.

MEASUREMENT.

Calculator.

The Calculator Board and Graphic Methods. Illustrates and describes an improved drawing board and apparatus for facilitating graphic methods of calculation, and the like. 1600 w. Elec Rev, Lond—Aug. 28, 1903. No. 57712 A.

Constants.

Determining Design Constants from Practice. Sanford A. Moss. Gives a method of working up known facts so as to obtain the various stresses, bearing pressures, and other design constants. 2700 w. Am Mach—Sept. 24, 1903. No. 57951.

Graphics.

Illustrations of Graphical Analysis. J. Harrison. Read before the British Assn. A short account of applications of graphical processes to engineering computations which do not require undue labor. 1500 w. Engng—Sept. 18, 1903. No. 58103 A.

Locomotive Proportion by Graphical Methods. F. K. Caswell. The first of a series of graphical charts dealing with problems in locomotive design. 1300 w. Ry & Engng Rev—Sept. 5, 1903. No. 57756.

Indicator Diagrams.

Steam Engine Diagrams. Gives diagrams of a tandem compound engine of vertical marine type without condensation, explaining the information obtained from them. 1700 w. Naut Gaz—Sept. 17, 1903. No. 57919.

Micrometers.

Measuring Instruments of High Precision (Instruments de Mesure de Haute Précision). A. Galassini. Especially describing the micrometers of Bariquand & Marre, as adapted for precise measurements in the workshop. 7000 w. Revue de Mécanique—July 31, 1903. No. 58048 E + F.

Power Measurement.

Measuring the Horse-Power of Steam Engines. E. C. Oliver. Gives results of a series of tests which were intended to show the effect on the average horse-power of taking indicator diagrams at various intervals simultaneously and at various intervals in rotation. 1200 w. Power—Sept., 1903. No. 57649 C.

Pyrometry.

The Application of the Laws of Radiation to Pyrometery (L' Application des

Lois du Rayonnement à la Pyrometrie). Ch. Féry. Describing a form of optical pyrometer, by means of which high temperatures may be measured from the radiant heat emitted. 2000 w. Rev Gen des Sciences—Sept. 15, 1903. No. 58053 D.

Testing.

The Testing Laboratory of the Conservatoire des Arts et Metiers (Laboratoire des Essais lu Conservatoire des Arts et Métiers). P. Breuil. A general description of the new mechanical laboratory in Paris, with illustrations of the hydraulic machinery and testing appliances. Serial. Part I. Génie Curl—Sept. 5, 1903. No. 58006 D.

POWER AND TRANSMSISION.

Aërial Tramways.

Aërial Tramways. Stephen de Zouiboria. Address before the Am. Min. Cong., at Deadwood. Considers the advantages of rope tramways, the systems, construction, cost of installation, etc. 2000 w. Ir Age—Sept. 24, 1903. No. 57950.

Compressed Air.

Compressed Air as a Motive Power Underground. T. G. Oliver. Abstract of a paper read before the Monkland Improvement and Debating Soc., Gympie, Q. Considers the serviceable pressure and the methods of application. 3300 w. Queens Gov Min Jour—July 15, 1903. No. 57699 B.

Conveying.

See Gas Works Engineering.

Elevators.

A New Spiral Elevator. Illustrated description of a novel type of elevator. 900 w. Eng Rec—Aug. 29, 1903. No. 57637.

Gearing.

The Choice of Angle of Obliquity for Involute Gearing (Sur le Choix de l'Obliquité de la Ligne d' Engrènement pom les Engrenages à Développante). Edmond Dubosc. A discussion of the effect of various angles of obliquity upon the interference of involute gear teeth. Serial. Part I. 3500 w. Revue de Mécanique—Aug. 31, 1903. No. 58049 E + F.

Gears.

Spiral Gears. C. E. Coolidge. Development of theory and rules for their calculation. 2000 w. Mach, N Y—Sept., 1903. No. 57666 C.

Hoisting.

Tests of the Efficiency of Hoisting Tackle. S. L. Wonson. A report of tests recently carried out by the erecting department of the American Bridge Co. of New York. 1000 w. Eng Rec—Sept. 12, 1903. No. 57882.

Tests of the Efficiency of Hoisting Tackle. S. P. Mitchell. A report of an extended series of tests made recently at the Pencoyd plant of the Am. Bridge Co. with standard types of blocks and various combinations of manila and wire rope. 800 w. Pro Am Soc of Civ Engrs—Aug., 1903. No. 57681 E.

Lubrication.

Lubrication of Textile Mills. William F. Parish, Jr. Extracts from a paper before the New England Cotton Mfrs. Assn. Discusses difficulties due to oils, and other matters relating to proper lubrication of heavy machinery. 3600 w. Am Mach—Sept. 10, 1903. No. 57810.

Shafts.

Theory of Stiff and Flexible Shafts and Critical Speeds. Sanford A. Moss. A detailed mathematical study of this theory. Ill. 2500 w. Power—Sept., 1903. No. 57648 C.

Speed Gears.

A Simple Speed Reducing Gear. Brief illustrated description of the invention of J. Sinclair Fairfax. 250 w. Engr, Lond —Sept. 18, 1903. No. 58108 A.

SPECIAL MOTORS.

Alcohol.

The Manufacture of Ethyl Alcohol from Wood. Describes the Classen process for the economical commercial manufacture of ethyl alcohol from wood, and gives information concerning plants to be erected in the United States. Ill. 3000 w. Ir Age—Sept. 17, 1903. No. 57868.

Carburetters.

Alcohol Carburetters. Capt. C. C. Longridge. Considers the design of alcohol carburetters. 1500 w. Engr, Lond—Aug. 28, 1903. No. 57720 A.

Gas Engines.

A Further Note on Gas-Engine Explosions. H. E. Wimperis. Read before the British Assn. The writer in a former paper considered the experiments of Mr. Dugald Clerk; and in the present paper considers the experiments of Mr. Grover, comparing the two and endeavoring to reconcile the previously inconsistent results. 2500 w. Engng—Sept. 18, 1903, No. 58104 A.

Compression in the Gas Engine. W. H. Booth. Information on the degree of compression to which gas engines can safely be worked, with diagrams. 700 w. Elec Rev, Lond—Aug. 21, 1903. No. 57576 A.

Four-Cylinder Gas Engine. Illustrates and describes an engine designed to develop 150 horse-power, at a speed of 250 revolutions per minute using producer gas. 1000 w. Engr, Lond—Aug. 28, 1903. No. 57721 A.

Gas Engine Principles and Management. E. W. Roberts. Illustrates and describes the principles of the two types in general use, and of accessory devices for using liquid fuels, discussing the management, troubles, and related matters of interest. 6500 w. Eng News—Sept. 17, 1903. No. 57944.

The Gas Engine and the Gas Turbine. George E. Walsh. Discusses the probability of the gas turbine becoming a success, and the future of the gas engine. 1400 w. Elec Rev, N Y—Sept. 5, 1903. No. 57757.

The Large Gas Engine in Great Britain. William H. Barth. An illustrated study of its development and the influence of blast furnace gas, present practice, various types, etc. 4000 w. Cassier's Mag—Sept., 1903. No. 57939 B.

Kerosene vs. Gasoline.

Test of Engine Using Kerosene and Gasoline. H. F. Halladay and G. O. Hodge. Tests made to determine the economic performance of a standard internal-combustion engine using these fuels respectively, under otherwise similar conditions. 1700 w. Mech Engr—Aug. 22, 1903. Serial. 1st part. No. 57571 A.

Petroleum Motors.

Applications of Petroleum Motors to Navigation (Application des Moteurs à Pétrole à la Navigation). A. Bochet. Describing numerous applications, especially as an auxiliary to sailing vessels and for driving auxiliary machinery. 6000 w. 1 plate. Mem Soc Ing Civ de France—June, 1903. No. 58025 G.

STEAM ENGINEERING

Boilers.

Boiler Bracing. Charles L. Hubbard. The first of a series of articles giving directions for this work. 1200 w. Mach, N Y—Sept., 1903. Serial. 1st part. No. 57664 C.

Boiler Corrosion. Explains what corrosion is, and the different causes and various means by which it may be remedied or prevented. 2700 w. Mines & Min—Sept., 1903. No. 57595 C.

The Circulation of Water in Steam Boilers (La Circulation de l'Eau dans les Chaudières à Vapeur). A. Montupet. An exhaustive analysis of the nature and effect of circulation in boilers, and the extent to which it can be controlled and regulated. 15000 w. 1 plate. Mem Soc Ing Civ de France—June, 1903. No. 58024 G.

Water-Tube Boilers. Albert E. Lea. Read before the Engng. Assn. of N. S. W. Considers briefly the progress and development made in these boilers during the past thirty years, their advantages, etc., describing a Babcock & Wilcox boiler. 3000 w. Aust Min Stand—July 30 and Aug. 5, 1903. Serial. 2 parts. No. 57703 each B.

Boiler Setting.

A Modified Boiler Setting. John E. Sweet. Illustrated description. 700 w. Power—Sept., 1903. No. 57651 C.

Boiler Tubes.

Locomotive Boiler Tubes. Lawford H. Fry. Discusses the effect of tube spacing. 900 w. R R Gaz—Sept. 11, 1903. No. 57829.

Boiler Water.

A Plea for Better Boiler Water. John H. Wynne. Discusses the presence of scale-forming materials in water, the effect of scale upon boilers, impurities, etc. 2200 w. Ry Mas Mech—Sept., 1903. Serial. 1st part. No. 57731.

Circulating Pipe.

The Sheedy Circulating Pipe for Locomotive Cylinders. Illustrates and describes the device and its operation. 700 w. Am Engr & R R Jour—Sept., 1903. No. 57659 C.

Condensers.

A 6,000 Horse-Power Conover Jet Condenser. Illustrated description. 1700 w. Power—Sept., 1903. No. 57647 C.

Surface Condensing Plant for Coal and Iron Works. Illustrates and describes an interesting plant recently installed in England, designed to deal with the exhaust from two winding engines, one fan engine, and two Parsons turbine electrical generators. 1600 w. Engng—Sept. 4, 1903. No. 57853 A.

Cylinders.

Cutting of Cylinders. Charles H. Garlick. Discusses the causes of cutting. 1500 w. Engr, U S A—Sept. 1, 1903. No. 57775 C.

Engine Test.

Test of a 250 H. P. Tandem Compound Engine by Van den Kerchove, of Ghent (Untersuchung einer von Van den Kerchove in Genut gebauten Tandemmaschine von 250 P S). Prof. M. Schröter and A. Koob. Data and results of tests with saturated and superheated steam, showing a gain of 17 per cent. by superheating. Serial. Part I. 4000 w. Zeitschr d Ver Deutscher Ing—Sept. 5, 1903. No. 58016 D.

Engines.

The Lefèvre Four-Cylinder High-Speed Engine. Illustrates and describes an ingenious type of steam-engine. 1000 w. Engng—Aug. 28, 1903. No. 57725 A.

Fire Boxes.

Defects in Locomotive Fireboxes and the Brotan Tubular Firebox (Defekte an

Lokomotivkesseln Normaler Bauart und das Neue Lokomotiv-Rohrboxkessel System Brotan). J. Brotan. An examination of the weakness of stayed fire boxes for locomotive boilers, and a description of a design constructed of water tubes. Two articles. 8000 w. Zeitschr d Oesterr Ing u Arch Ver—Aug. 21, 28, 1903. No. 58038 each D.

Piping.

The High-Pressure Steam Piping at the Düsseldorf Exhibition (Die Hochdruck-Dampfrohrleitungen auf der Ausstellung in Düsseldorf). W. Stahl. With plans of the steam mains and general management of the connections to the boilers. Two articles. 7500 w. Zeitschr d Ver Deutscher Ing—Aug. 15, 22, 1903. No. 58011 each D.

Reheaters.

The Use of Reheaters in Compound Engines. George H. Barrus. Abstract of a paper presented to the New England Cotton Mfrs. Assn. Gives results of tests made by the writer, discussing the effects noticed. 2000 w. Power—Sept., 1903. No. 57652 C.

Safety Valves.

Improvements in Steam Boiler Fittings (Neuerungen an Dampfkesselarmaturen). Discussing especially recent forms of balanced safety valves and pressure-reducing valves. 1800 w. Glückauf—Sept. 5, 1903. No. 58075 B.

Steam Turbines.

Recent Developments of the Steam Turbine. A. Rateau. An illustrated discussion of the latest types of steam turbine, including the low as well as the high pressure machines. 3500 w. Engineering Magazine—Oct., 1903. No. 58084 B.

Recent Steam Turbine Developments. W. L. R. Emmet. A discussion of design, with explanation of changes made, and report of tests. General discussion. 7500 w. St Ry Rev (Daily Ed)—Sept. 4, 1903. No. 57804 C.

The Steam Turbine (Die Dampfturbinen). A general description of the different types of steam turbine now in the market, showing their numerous applications for electrical and general driving. Two articles. 6000 w. Glückauf—Aug. 15, 22, 1903. No. 58072 each B.

The Curtis Steam Turbine and Its Manufacture. Illustrated detailed description of this turbine, its manufacture, and operation. 2500 w. Mach, N Y—Sept., 1903. No. 57661 C.

The Parsons Steam Turbine. G. R. Dunell. Gives a description of the elementary principles upon which the design is based, traces the development, and shows views of the various departments in the works at Heaton, near Newcastle-on-Tyne, where the land turbines are made. Also gives an illustrated description of the marine type. 10500 w. Trac & Trans—Sept., 1903. No. 57850 E.

Stuffing Boxes.

Engines and Pumps Without Stuffing Boxes. Andrew Watson. A paper read before the Min. Inst. of Scotland, on stuffing boxes without glands. Also abstract of discussion. Ill. 2000 w. Mech Engr—Aug. 29, 1903. No. 57704 A.

Superheating.

Superheating by Wire-Drawing. Frank Foster. Shows a diagram of the wire-drawing calorimeter, explaining its principle and discussing its value; also considers another method of superheating steam by wire-drawing. 1200 w. Feilden's Mag—Sept., 1903. No. 57964 B.

MISCELLANY.

Aeronautics.

Experiments and Observations in Soaring Flight. Wilbur Wright. An illustrated account of experiments made by the writer. Also short discussion. 7000 w. Jour W Soc of Engrs—Aug., 1903. No. 57979 D.

The Disclosure of a Secret, and the Application to Aërial Navigation. Sidney Orville Brown. A study of soaring birds, with suggestions for applying the same principle to aeroplanes. 1000 w. Sci Am Sup—Sept. 19, 1903. No. 57891.

The Flying Machine and Its Slow Development. A brief review of the development, discussing the various theories. 2500 w. Sci Am Sup—Sept. 12, 1903. No. 57818.

The Lebaudy Airship. Describes the general principles on which the machine is built, with special details of its construction. Ill. 2000 w. Auto Jour—Aug. 29, 1903. No. 57696 A.

The Spencer Airship for 1903. Frederick A. Talbot. An illustrated detailed description of the improved design. 1700 w. Sci Am—Sept. 5, 1903. No. 57772.

Applied Science.

Engineering and Chemistry (Ingenieurwissenschaft und Chemie). Dr. W. Ostwald. An address delivered at the Münich meeting of the Verein Deutscher Ingenieure, showing the extent to which the work of the engineer and the chemical technologist harmonizes. 4000 w. Zeitschr d Ver Deutscher Ing—Aug. 29, 1903. No. 58015 D.

Bottles.

Making Bottles by Machinery (Fabrication Mécanique de Bouteilles). H. Aurive. An illustrated description of the

Appert system of making bottles, with a review of other mechanical methods. 3000 w. Rev Technique—Aug. 10, 1903. No. 58020 D.

Heat.

Laws of Heat Radiation. J. Blacklock Henderson. Read before the Glasgow Univ. Phys. Soc. An experimental study. 3700 w. Elect'n, Lond—Aug. 28, 1903. No. 57714 A.

Lead Burning.

The Art and Practice of Lead Burning by Aero-Hydrogen and Coal Gas. Arthur R. Baldwin. (Second Prize Essay). Considers what lead burning is, where necessary, advantages and disadvantages, and the work. Ill. 2400 w. Plumb & Dec—Sept. 1, 1903. No. 57831 A.

Machinery.

The Age of Machinery and Its Relation to Public Welfare (Das Maschinenzeitalter in Seinem Zusammenhang mit dem Volkswohlstand und der Sozialen Verpassung der Volkswirtschaft). Gustav Schmoller. An address delivered before the Münich convention of the Society of German Engineers showing the great influence of machinery upon civilization. 6000 w. Zeitschr d Ver Deutscher Ing—Aug. 15, 1903. No. 58010 D.

Ovals.

A New Method of Drawing Ovals (Un Nouveau Tracé des Ovales). M. LeClerc de Pulligny. Deriving a method of drawing an arch of five circular arcs closely approximating a true ellipse. 1200 w. Ann des Ponts et Chaussées—1 Trimestre, 1903. No. 58047 E + F.

Sugar Works.

The Sugar Works of Ketzin, near Berlin (Sucrerie de Ketzin, près de Berlin). Illustrated description of large beet sugar plant. 1000 w. 1 plate. Génie Civil—Aug. 22, 1903. No. 58002 D.

Thermodynamics.

Entropy, or Thermodynamics from an Engineer's Standpoint. J. Swinburne. An explanation of the term as employed in the thermodynamics of reversible and irreversible changes, aiming to make the theory clear. 6500 w. Engng—Aug. 28, 1903. Serial. 1st part. No. 57724 A.

The Reversibility of Thermodynamics. J. Swinburne. Read before the British Assn. Proposes a different treatment of the subject of thermodynamics in the hope of making the science more easily understood. 5500 w. Elec Rev, Lond—Sept. 18, 1903. No. 57995 A.

MINING AND METALLURGY

COAL AND COKE.

Briquettes.

The Lignite Briquette Works of the Lauchhammer Company (Die Braunkolenbrikettfabrik der Aktiengesellschaft Lauchhammer). A description of the briquette works of Lauchhammer, Prussia, with details of the process by which the local brown coal is compressed into serviceable fuel. 2000 w. 1 plate. Glückauf—Aug. 29, 1903. No. 58073 B.

Coal Cutting.

The Use of Stanley Coal-Heading Machines in the Rapid Development and Working of the Nuneaton Colliery, Warwickshire. F. C. Swallow. On the geology of this district, the coal seams, the working and costs, with discussion. 2500 w. Col Guard—Sept. 11, 1903. No. 57-907 A.

Coal-Field.

The Arkansas--Indian Territory Coal-Field. Franklin Bache. Describes the deposits and gives an account of the workings. 2800 w. Eng & Min Jour—Sept. 12, 1903. No. 57886.

Coke Ovens.

The Regulation of the Combustion and Distribution of the Temperature in Coke Oven Practice. D. A. Louis. Brief illustrated descriptions of a number of ovens and the practice followed, especially the Brunck system and the Bauer system. Ill. 4400 w. Ir & Coal Trds Rev—Sept. 4, 1903. No. 57863 A.

Electric Powers.

See Electrical Engineering, Power Applications.

Fuel.

Coal as Fuel at Barrow-in-Furness. W. F. Pettigrew. An account of experiments made to find the relative value of coals obtained from various districts in England, Scotland and Wales. 3800 w. Ir & Coal Trds Rev—Sept. 4, 1903. No. 57-860 A.

Great Britain.

Re-Survey of the Carboniferous Strata in Derbyshire and Nottinghamshire. From the "Summary of Progress of the Geol. Surv.," 1902. Describes the work of examining these coal measures. 4000 w. Ir

& Coal Trds Rev—Sept. 11, 1903. No. 57916 A.

The Coal Mining Industry of the United Kingdom. R. A. S. Redmayne. The first of a series of papers discussing the development of British coal mining. The present article deals largely with the historical portion of the subject. 3500 w. Engineering Magazine—October, 1903. No. 58-082 B.

India.

Seebpore Coal. Frederick Grover. Information concerning a practical test made of this coal, pronouncing it satisfactory. 1500 w. Jour Soc of Arts—Sept. 4, 1903. No. 57873 A.

Lignite.

Notes on the Bohemian Lignite Industry (Einiges vom Böhmischen Braunkohlenbergbau). H. Prietze. An account of the methods used in working the brown coal deposits of northwestern Bohemia. 1500 w. Glückauf—Sept. 5, 1903. No. 58074 B.

Queensland.

Dawson-Mackenzie Coal Fields B. Dunstan. Illustrated article giving information of the deposits, quality of the coal, etc. 800 w. Queens Gov Min Jour —July 15, 1903. No. 57698 B.

Selenium.

Selenium in Coke. J. F. Smith. Read before the Yorkshire Sec. of the Soc. of Chem. Ind. An account of investigations, giving results. 1000 w. Aust Min Stand—July 23, 1903. No. 57702 B.

South Wales.

The Coal Measures of Llanelly, Llannon, and Cross Hands, in the South Wales Coal Field. From the Memoirs ot the Geol. Surv. 10000 w. Ir & Coal Trds Rev—Aug. 28, 1903. No. 57729 A.

Supplies.

Report of the Royal Commission on Coal Supplies. The first instalment of a digest of evidence taken last year before the Commission. The working of thin seams is considered in the present number. 5600 w. Col Guard—Aug. 28, 1903 Serial. 1st part. No. 57715 A.

West Virginia.

Analyses and Fuel Value of the Pittsburg Coal in the Fairmont Region of West Virginia. Frank Haas. Reprinted from W. Va. Geol. Survey. Shows the influence of different constituents upon the value of the coal. 3400 w. Mines & Min—Sept., 1903. No. 57597 C.

COPPER.

Bessemer Process.

The Bessemer Copper Process. Describes briefly the latest method of copper converting, under the improved process of Paul David. Ill. 900 w. Sci Am—Sept. 26, 1903. No. 57959.

Concentration.

Method of Concentrating at Anaconda. M. Schwerin. Describes the method, the object being to produce a concentrate with a greater percentage of copper and iron and less silica than the crude ore. 2000 w. Eng & Min Jour—Sept. 12, 1903. No. 57885.

Electric Smelting.

See Electrical Engineering, Electrochemistry.

Low-Grade Ore.

Leaching Low-Grade Copper Ore. Considers the successful treatment by the cost process when the ores are susceptible of leaching. 3500 w. Min & Sci Pr—Sept. 12, 1903. No. 57896.

Nevada.

The Ore Deposit at Contact, Nevada. Chester W. Purington. Abstract of a paper in the Pro. of the Colorado Sci. Soc., describing these copper bearing deposits. Ill. 2000 w. Eng & Min Jour —Sept. 19, 1903. No. 57941.

Smelting.

Pyritic Smelting. Franklin R. Carpenter. Trans. Am. Min. Cong., Deadwood, S. D. Describes a process of smelting applicable to any raw ores not carrying lead, but especially to sulphide ores carrying copper. 1100 w. Min & Sci Pr—Sept. 12, 1903. Serial. 1st part. No. 57895.

GOLD AND SILVER.

Bendigo.

The Synclinal or "Inverted Saddle" Reefs at the Bendigo Goldfields. Wm. H. Cundy, in *Trans. Aust. Inst. of Min. Engrs.* An illustrated article considering the formation, characteristics, etc. 2200 w. Can Min Rev—Aug. 31, 1903. No. 57753 B.

Black Hills.

Black Hills, South Dakota. Notes on mills and mill work, with illustrations. 3800 w. Min Rept—Sept. 3, 1903. No. 57736.

Ore Deposits of the Northern Black Hills. J. D. Irving. Trans. Amer. Min. Cong., Deadwood, S. D. (Condensed.) The present article deals principally with the geology of this region. 1000 w. Min & Sci Pr—Sept. 12, 1903. Serial. 1st part. No. 57894.

California.

Some Structural Features of the California Gold Belt. W. H. Storms. Illustration and description of these features of the section known as the Mother Lode. 1600 w. Min & Sci Pr—Aug. 22, 1903. Serial. 1st part. No. 57613.

Concentration.

Two Notable Concentrating Plants. G. A. Burr. Illustrates and describes two plants within a quarter of a mile of each other, treating nearly identical ores with very different methods. The ores contain silver, gold, lead, zinc, iron, copper, and silica. 1200 w. Eng & Min Jour—Sept. 12, 1903. No. 57887.

Crushing.

A System of Crushing Rock in Stages by Wet Process and Suggestions as to How This Object Can Best Be Achieved. Edward D. Chester. A discussion of this paper taken as read. 1500 w. Jour Chem, Met & Min Soc of S Africa—July, 1903. No. 57709 E.

Cyaniding.

Cyanidation at the Kalgurli Mine, Kalgoorlie. Edwin O. Watt. Abstracted from the *Trans.* of the Australasian Inst. of Min. Engrs. Illustrates and describes the treatment of this ore. 2700 w. Eng & Min Jour—Aug. 29, 1903. No. 57631.

Cyaniding Methods at the Homestake Plant. C. W. Merrill. An interesting illustrated description of the actual practice. 4500 w. Pacific C Min—Aug. 29, 1903. No. 57733.

Deposits.

Bonanzas and Pockets of Ore. Prof. Arthur Lakes. Considers some of the causes of their deposition and origin as illustrated in various mines. Ill. 1800 w. Mines & Min—Sept., 1903. No. 57591 C.

Dredging.

Dredging at Oroville. Newton B. Knox. Abstract of a paper in the *Pro.* of the Inst. of Min. & Met., London. Brief account of the dredge-mining for gold in California. 900 w. Eng & Min Jour—Aug. 29, 1903. No. 57632.

Extraction.

A Modern Gold-Reduction Plant on the Witwatersrand Goldfield. Gives details of the extraction processes, with illustrations. 2000 w. N Z Mines Rec—July 16, 1903. No. 57832 B.

New Zealand.

The Gold Dredging Industry in New Zealand. William Wylie, in *Trans. Aust. Inst. of Min. Engrs.* Reviews the development of this industry, methods tried, and describes present practice. 4000 w. Can Min Rev—Aug. 31, 1903. No. 57754 B.

Ore Treatment.

Roasting and Filter-Press Treatment at Kalgoorlie. J. T. Marriner. Describes the treatment of these sulpho-telluride ores, and also the filter-press used, giving costs. 2700 w. Eng & Min Jour—Sept. 5, 1903. No. 57784.

Volatilization of Metals as Chlorides. Stuart Croasdale. Relates to the volatilization of metals as chlorides from their ores during a chloridizing roast. 4500 w. Eng & Min Jour—Aug. 29, 1903. No. 57629.

Placers.

The Problem of Dry-Placers. Henry A. Mather. Considers the difficulties of gold recovery and the means employed. 1200 w. Eng & Min Jour—Aug. 29, 1903. No. 57630.

Precipitation.

The Precipitation of Gold from Cyanide Solutions. W. A. Caldecott and E. H. Johnson. A discussion of the main features, with explanation of processes and methods, and suggestions for research. 4500 w. Jour Chem, Met & Min Soc of S Africa—July, 1903. No. 57708 E.

Pyrites.

Treatment of Pyrites Containing Combined Gold. An account of a new process being used for the treatment of auriferous arsenical pyrites of Piedmont, Italy, by a Belgian company. 800 w. Sci Am Sup—Sept. 26, 1903. No. 57961.

Transvaal.

The Future of the Transvaal (Le Transvaal et Son Avenir). Raphael-Georges Lévy. An exhaustive review of the mineral resources of the Transvaal, and of the prospects of their future development. 15000 w. Bull Soc d'Encour—July 31, 1903. No. 58041 G.

Witwatersrand.

Observations on the Metallurgical Practice of the Witwatersrand. H. S. Denny. Discusses the more important points in the treatment of gold ores; crushing, sorting, milling, amalgamation, concentration, classification of sands and slimes, cyaniding of sands, and cyaniding of slimes. Ill. 24000 w. Jour Chem, Met & Min Soc of S Africa—July, 1903 No. 57706 E.

IRON AND STEEL.

Baraboo District.

The Baraboo Iron District Mining Developments. A report of recent developments in Wisconsin. 2000 w. Ir Age—Sept. 17, 1903. No. 57870.

Castings.

See Mechanical Engineering, Machine Works and Foundries.

Crystallization.

Crystallization of Iron and Steel. William A. Doble's contribution to a discussion at the July meeting of the Pacific Coast Ry. Club, giving an account of the results of long and careful study.

7000 w. Ry Age—Sept. 4, 1903. No. 57747.

Electric Power.

See Electrical Engineering, Power Applications.

Furnace Explosions.

Explosions Caused by Obstructions in Blast Furnaces (Ueber die durch das Hängen der Gichten Veranlassten Hochofenexplosionen). Adalbert Nath. A discussion of the causes of gas explosions in blast furnaces, including the effects of increased temperatures upon dissociation of the gases. 1800 w. Stahl u Eisen—Aug. 15, 1903. No. 58029 D.

Iron Ore.

The Probability of Iron Ore Lying below the Sands of the Duddon Estuary. James Leslie Shaw. Gives some undoubted facts in support of the assumption that there are deposits of good quality and quantity, describing the faulting, and suggestions for exploration work. 2700 w. Ir & Coal Trds Rev—Sept. 4, 1903. No. 57861 A.

Iron Trade.

See Industrial Economy.

Magnetite.

Magnetite Deposits at Mineville, N. Y. Heinrich Reis. Describes the ore bodies, and the new electric concentrating plant. Ill. 2000 w. Mines & Min—Sept., 1903. No. 57590 C.

Nickel Steel.

See Mechanical Engineering, Materials.

Pig Iron.

Buying Pig Iron on Specification. Herbert E. Field. Read at meeting of the Am. Found. Assn. Considers the specification and its use. 2400 w. Foundry—Sept., 1903. No. 57983.

Rails.

Notes on the Heat Treatment of Steel Rails High in Manganese. J. S. Lloyd. Read before the Ir. & Steel Inst. 900 w. Engng—Sept. 11, 1903. No. 57912 A.

Sorbitic Steel Rails. J. E. Stead and Arthur W. Richards. Read before the Iron & Steel Inst. Gives a description ot experiments in making sorbitic rails, and their relative wear. 3500 w. Engng—Sept. 4, 1903. No. 57854 A.

Rolling Mills.

Evolution of the Rolling Mill. Extracts from an article by T. J. Brown, published in *Camp and Plant*. Describes the merchant steel department of the Minnequa works at Pueblo, Colo. Also sketches the evolution of the rolling ot merchant steel in the United States. 5500 w. Ir Trd Rev—Aug. 27, 1903. No. 57589.

See Mechanical Engineering, Machine Works and Foundries.

Silicon.

The Influence of Silicon on Iron. Thomas Baker. An account of research, having for its object the preparation ot a series of alloys of silicon and iron, and a study of the microstructure, mechanical and physical properties. 2700 w. Ir & Coal Trds Rev—Sept. 4, 1903. No. 57862 A.

Steel.

Diseases of Steel. C. H. Ridsdale Read before the Iron & Steel Inst. Considers faults originating during manufacture, traced forward; and faults manifested, and traced backward. The prevention and cure. 16500 w. Ir & Coal Trds Rev—Sept. 4, 1903. No. 57859 A.

Some Elements Used in Steel-Making. Considers the influence on steel of tungsten, molybdenum, vanadium, and uranium. 2500 w. Engr, Lond—Sept. 18, 1903. No. 58106 A.

The Burning and Overheating of Steel. Alfred Stansfield. A study of the conditions under which the steel becomes "burnt," the nature of this so-called "burning," and the way it can be rendered suitable for use. 5200 w. Ir & Coal Trds Rev—Sept. 4, 1903. No. 57864 A.

The Restoration of a Dangerously Crystalline Steel by Heat Treatment. J. E. Stead and Arthur W. Richards. Read before the Iron & Steel Inst. An account of the authors' work in studying the effect of heat on the mechanical properties of steel. 5000 w. Engng—Sept. 4, 1903. No. 57856 A.

Steel Production.

Steel Production Three Decades Ago and To-day. Andrew Carnegie. Presidential address, delivered before the Iron and Steel Inst., at Barrow-in-Furness, England. 1800 w. Eng News—Sept. 10, 1903. No. 57824.

Swedish Lapland.

Iron Ores of Arctic Lapland. Chase S. Osborn. A report of these iron-ore fields, located beyond the Arctic circle, the character of the ores, methods of mining, etc. 1800 w. Ir & Coal Trds Rev—Sept. 11, 1903. No. 57917 A.

MINING.

Accidents.

Fatal Accidents in Coal Mines in North America, 1902. Frederick L. Hoffman. Statistics showing a decided increase in the fatal accidents. 1000 w. Eng & Min Jour—Sept. 5, 1903. No. 57783.

Borneo.

Mining in Dutch West Borneo. M. W. von Bernewitz. Gives important points of mining laws, with comments. 2000 w.

Aust Min Stand—Aug. 13, 1903. No. 57834 B.

Drying.

The Mechanical Drying of Minerals. C. O. Bartlett. Read at Mining Congress, Deadwood. Considers products of value now coming into use and the treatment they require. Especially considers Portland cement, and methods of drying minerals. 2000 w. Min Rept—Sept. 17, 1903 No. 57921.

Electric Drills.

Electric Rock-Drills. E. J. Munby. A discussion of the application of electricity to drilling, showing its utility, economy, etc. 1800 w. Stevens Ind—July, 1903. No. 57680 D.

Electric Power.

See Electrical Engineering, Power Applications.

New Mexico.

The Geology of the Cerrillos Hills, New Mexico. Douglas Wilson Johnson. Aims to give a fairly complete account of the geology of this district. Ill. 16500 w. Sch of Mines Qr—April, 1903. Serial. 1st part. No. 57971 D.

Shaft Sinking.

The Latest Progessive Shaft Sinking Chief Engineer Riemer. Translated from the "Report of the Eighth General German Mining Congress at Dortmund." A discussion of the advances that have been made. Ill. 14000 w. Sch of Mines Qr. No. 57972 D.

Timbering.

Systematic Timbering: Report of the Prussian Commission on Falls of Roof and Coal. Abstract from this report, dealing with general observations on timbering in the different countries visited. Ill. 2800 w. Col Guard—Aug. 28, 1903. No. 57717 A.

Valuation.

Cost per Ton as a Basis of Mine Valuation. R. Gilman Brown. Considers the method of determining the cost per ton. 2000 w. Eng & Min Jour—Aug. 29, 1903. No. 57628.

Ventilation.

The Ventilation of Deep Levels. Thomas Johnson. Considers means of securing efficient ventilation. Ill. 6000 w. Jour Chem, Met & Min Soc of S Africa—July, 1903. No. 57707 E.

Winding.

Traversing Winding Engine for Deep Shafts. H. M. Morgans. Illustrates and describes a plant which avoids many of the difficulties of deep winding. 4000 w. Mines & Min—Sept., 1903. No. 57593 C.

Wolfram Camp.

Wolfram, Molybdenite, and Bismuth Mining, at Wolfram Camp, Hodgkinson Goldfield. Walter E. Cameron. Deals with the geology, working, etc. 3500 w. Queens Gov Min Jour—July 15, 1903. No. 57700 B.

MISCELLANY.

Arsenic.

A Rapid Method for the Determination of Arsenic in Arsenopyrite. J. L. Danziger and W. H. Buckhout. Results of a series of experiments are given. 1600 w. Sch of Mines Qr—April, 1903. No. 57973 D.

Diamonds.

Diamond Mining in the Kimberley Field. Charles V. Allen. An illustrated account of the modern methods employed in working the diamond mines of South Africa. 4000 w. Engineering Magazine —Oct., 1903. No. 58087 B.

The Diamond District of the Vaal River. T. Lane Carter. A description of the methods of working, and of the deposits. Ill. 1400 w. Eng & Min Jour —Sept. 5, 1903. No. 57785.

Gypsum.

The Gypsum of the Eden Valley. David Burns. Read before the Inst. of Min. Engrs. at Keswick. An account of these mines, describing the deposits and discussing their origin. Brief general discussion. 5000 w. Quarry—Sept., 1903 No. 57794 A.

Manganese.

A study of Manganese Steel (Recherches sur les Aciers au Manganese). Leon Guillet. A study of the properties of manganese steel, making use of the methods of metallography. Two articles. 4000 w. Génie Civil—Aug. 22, 29, 1903 No. 58001 each D.

Metallography.

See Mechanical Engineering, Materials.

Minerals.

Cutting and Polishing Mineral Specimens. Prof. Frank W. Brady. Gives a method of constructing apparatus at a small cost by which specimens may be prepared for exhibit or use. Ill. 1500 w. Mines & Min—Sept., 1903. No. 57594 C.

Petroleum.

Petroleum in California. Edmond O'Neill, in *Jour. Am. Chem. Soc.* Information concerning the deposits, quality, use, character, etc. 4000 w. Am Gas Lgt Jour—Sept. 7, 1903. No. 57744.

The Oil Industry of California from a Commercial Standpoint. Dr. C. T. Deane. Read before the Pacific Coast Gas Assn. Gives some information 'in regard to oil wells, cost of sinking, production, consumption, etc., showing the commercial value. 4000 w. Am Gas Lgt Jour—Aug. 31, 1903. No. 57598.

Separation.

Magnetic Separation of Tin and Wolfram at Gunnislake Clitters. Edward Skewes. Describes the work accomplished by a magnetic separator having a capacity of about 5 tons per day. 700 w. Eng & Min Jour—Sept. 19, 1903. No. 57940.

Zinc.

The Electro-Metallurgy of Zinc (Electro-Métallurgie du Zinc). A. Salguès. A description of the electric furnace and process for the smelting of zinc in operation at Crampagua, Ariège, France. 9000 w. Mem Soc Ing Civ de France—July, 1903. No. 58028 G.

RAILWAY ENGINEERING

MOTIVE POWER AND EQUIPMENT.

Brakes.

The Combined Straight Air and Automatic Engine and Tender Brake. Extracts from a paper before the Traveling Engrs. Assn., by Frank P. Roesch. Some points in braking, discussing changes made necessary by new conditions, and setting forth the advantages of the brake named. 1000 w. R R Gaz—Sept. 18, 1903. No. 57949.

Cars.

Best Method of Painting and Maintaining Steel Cars. Two papers, by J. D. Wright, and W. O. Quest, read before the Master Car & Soc. Paint. Assn. On the best protective coatings, way of applying, etc. 3800 w. Ry Age—Sept. 11, 1903. No. 57877.

Box Car with Strong End Construction, for the Central Railroad of New Jersey. Illustrated description. 1000 w. Loc Engng—Sept., 1903. No. 57739 C.

Car of 50 Tons Capacity in Pressed Steel (Wagon de 50 Tonnes en Tole d'Acier Embontie). Ch. Dantin. Illustrated description of 50-ton pressed-steel coal car of French manufacture. 1000 w. Génie Civil—Sept. 12, 1903. No. 50009 D.

Distributed Cost of Car Repairs. Gives a table showing the results of a carefully kept record in an important trunk line for the year 1902. 350 w. Am Engr & R R Jour—Sept., 1903. No. 57657 C.

Private Owners' Wagons. Revised specifications and drawings issued by the Railway Clearing House Committee of England. 2300 w. Col Guard—Aug. 28, 1903. No. 57716 A.

Steel-Frame Side-Door Passenger Car—Illinois Central R. R. Illustrated detailed description, with discussion of the design. 2 plates. 3800 w. Ry Age—Sept. 4, 1903. No. 57746.

Couplings.

Automatic Couplings for Railway Rolling Stock. Ernst Sauer. Abstract from *Glaser's Annalen*. Discusses the adaptability of the American Master Car Builders' couplers in connection with the German screw couplers. Ill. 5500 w. Bul Internat Ry Cong—Aug., 1903. No. 57814 E.

Fire-Box Stays.

Locomotive Fire-Box Stays. Francis William Webb. An illustrated description of a number of trials made, with conclusions. Also a summary of the discussion. 5000 w. Bul Internat Ry Cong—Aug., 1903. Serial. 1st part. No. 57812 E.

Locomotive Boilers.

Special Features in the Design of Locomotive Boilers and Fireboxes. Charles S. Lake. Discussing the efforts to increase the steaming efficiency of the boiler to meet the increased demands for hauling power and speed. The first of two articles. 3500 w. Engineering Magazine—Oct., 1903. No. 58085 B.

The Care of Locomotive Boilers. M. E. Wells. Second prize paper of the Pacific Coast Ry. Club. Details of care needed. 5000 w. Ry Age—Sept. 11, 1903. No. 57876.

Locomotives.

Care and Handling of the Compound Locomotive. A. L. Beardsley. Abstract of a paper before the Traveling Engrs.' Con. Suggestions helpful in obtaining good results, with mention of some things to be avoided. 2500 w. R R Gaz—Sept. 18, 1903. No. 57948.

Compound Locomotive with Superheater. Illustrates and describes a locomotive of the 4-6-0 type, equipped with the Schmidt system of superheating—Canadian Pacific Ry. 1100 w. Am Engr & R R Jour—Sept., 1903. No. 57656 C.

Four-Cylinder Compound Locomotive for the Jura-Simplon Railways. Illustrated detailed description. 1000 w. Engng—Aug. 28, 1903. No. 57726 A.

Mallet Articulated Locomotive for the Baltimore & Ohio. Elevation view and brief description of an engine having a frame hinged in the middle to allow of horizontal swing. 600 w. Ry Age—Sept. 4, 1903. No. 57748.

Narrow-Gauge Locomotives (Les Locomotives à Voie Etroite). H. Martin. With diagrams and data of a number of recently-constructed engines. Serial. Part 1. 2000 w. Genie Civil—Sept. 12, 1903 No. 58008 D.

Northern Pacific Consolidation Locomotive. Illustrated description of a heavy engine for freight service. 700 w. Ry Age—Aug. 28, 1903. No. 57599.

Oil--Burning Passenger Locomotive. Illustrated description of a Vauclain compound 4-4-2 type, for the Southern Pacific Ry. 300 w. Am Engr & R R Jour—Sept., 1903. No. 57658 C.

Saddle Tank Switching Locomotive. An illustrated description of the application of a wide firebox to a saddle tank switcher. 300 w. Ry Mas Mech—Sept., 1903. No. 57732.

Santa Fe Four-Cylinder Balanced Compound. Illustration, plan, cross sections, and detailed description. 1400 w. Ry Age—Sept. 18, 1903. No. 57923.

The New Caledonian Giants at Work. Charles Rous-Martin. On the performance of recently built engines for the Caledonian Railway. 3000 w. Engr, Lond—Aug. 21, 1903. No. 57586 A.

Rack Locomotives.

A Critical Description of Recent Rack Locomotives for Mixed Service (Kritische Beschreibung der bis jetzt Gebauten Zahnradlokomotiven für Gemischen Betrieb). A. Werner. A tabulated account of the various types of locomotives in use for rack railways on mountain inclines. Serial. Part I. 4000 w. Glasers Annalen—Aug. 15, 1903. No. 58021 D.

Shoes.

Lining of Shoes and Wedges. W. D. Chamberlin. Reproduced from the issue of Feb., 1900. An illustrated explanation of method recommended. 2800 w. Loc Engng—Sept., 1903. No. 57738 C.

Train Lighting.

Axle Lighting. Elmer A. Sperry. Discusses the advantages of electricity for car lighting, the progress, and the system of the future, announcing a new system of axle-lighting, with regulating devices. 3000 w. St Louis Ry Club—Aug. 14, 1903. No. 57795.

Electric Lights on Railway Trains in Germany and Austria. Illustrations with brief notes on the Dick system. 600 w. U S Cons Repts, No. 1740—Sept. 3, 1903. No. 57679 D.

The Lighting of Railway Carriages (Eclairage des Voitures de Chemins de Fer). An illustrated account of the successful use of incandescent gas mantles for lighting railway trains in France. 2000 w. Génie Civil—Aug. 22, 1903. No. 58003 D.

Train-Lighting on the Eastern Railway of France. An account of the difficulties met in using the system of incandescent gas-lighting, and the final type of lamp and burner adopted. Ill. 2500 w. Engng —Sept. 18, 1903. No. 58101 A.

Wheels.

Defects of Cast Iron Wheels and How to Inspect for Them. W. A. Mitchell. Suggestions helpful to inspectors. 2000 w. Loc Engng—Sept., 1903. No. 57737 C.

NEW PROJECTS.

Bagdad Railway.

The Bagdad Railway. Map and account of the projected railway, recalling the history of the region through which it passes, the ancient system of irrigation, and the disaster that destroyed these works, the possibility of reconstructing them, cost, etc. 3700 w. Engng—Sept. 18, 1903. No. 58100 A.

Simplon.

Connections to the Simplon Railway (Simplon et Faucille). Louis Lafitte. A discussion of the relation of the Simplon tunnel to the French railways, advocating a short connection of the Paris, Lyons & Mediterranean railway to the Jura-Simplon line by way of the Col de la Faucille. Two articles. 8000 w. Génie Civil—Aug. 29, Sept. 5, 1903. No. 58005 each D.

PERMANENT WAY AND BUILDINGS.

Ballast.

Ballast for Railways. Considers the kinds of ballast used and the value of each. 3000 w. Engr, Lond—Aug. 28, 1903. No. 57719 A.

Construction.

Construction Work on the Pennsylvania R. R. between Harrisburg and Gallitzin. An illustrated description of the work in progress, the methods employed, certain details of construction, and cost. 4400 w. Eng News—Sept. 24, 1903. No. 57957.

Cut-Off.

The Leamington Cut-Off of the Oregon Short Line R. R. in Western Utah. W. P. Hardesty. An illustrated detailed description of this important work. 5300 w. Eng News—Sept. 17, 1903. No. 57946.

Improvements.

The Illinois Central Improvements—New Lines and Second Track. An illustrated account of new lines, with a statement of the purpose they are to serve, and of second track work in progress. 2000 w. R R Gaz—Aug. 28, 1903. No. 57638.

Oklahoma.

Some Railway Construction in Oklahoma. A. G. Allan. An illustrated account of construction work on a line being built by the A., T. & S. F. Ry. from Newkirk, Ok., to Pauls Valley, Ind. Ter. 2000 w. Pro Am Soc of Civ Engrs—Aug., 1903. No. 57683 E.

Power Plant.

Power Plant of the Rock Island-Lake Shore Terminal Station, Chicago. Illustrates and describes the power plant which serves the station and terminal yards, furnishing electricity for power, lighting, switching and elevator service; compressed air for various uses; steam for heating, and water needed. 2400 w. Eng Rec—Sept. 19, 1903. No. 57932.

Reconstruction.

Baltimore & Ohio's Reconstruction. An account of the comprehensive improvements in progress in both roadbed and equipment. 2600 w. Ry Age—Sept. 18, 1903. No. 57922.

Shops.

New Locomotive Shops of the Chicago, St. Paul, Minneapolis & Omaha at Sioux City. Illustrated detailed description. 2400 w. R R Gaz—Sept. 11, 1903. No. 57830.

Signalling.

Automatic Block Signals for Railroads. Ralph Scott. An illustrated article explaining the general practice. 4500 w. Am Elect'n—Sept., 1903. No. 57779.

Stations.

Cupples Station—A Combined Freight Depot and Business Block. Earl Mayo. A description of this remarkable station in St. Louis, for handling, distributing and trans-shipment of goods. 1400 w. Sci Am—Aug. 29, 1903. No. 57614.

Connecting Stations Between Railways and Waterways (Des Gares de Raccordement entre Chemins de Fer et Voies Navigables). M. Mazoyer. Describing the railway connections of the canals of Roanne, the Loire, and the Nivernaise, illustrating the stations at the points of junction. 7000 w. 4 plates. Ann des Ponts et Chaussées—1 Trimestre, 1903. No. 58045 E + F.

The Rock Island Terminal Station, Chicago, Ill. An illustrated detailed description of a large station. 3400 w. Eng Rec—Sept. 12, 1903. No. 57881.

Ties.

A Review of the Railway Tie Question. Editorial discussion of the present condition and future prospects in regard to wooden ties, and brief review of other materials used. 3000 w. Eng News—Sept. 10, 1903. No. 57822.

Railway Ties and Tie Plantations in Mexico and South Africa. Gives information relative to the experience of two counties which have not a sufficient supply of suitable timber for ties. 2500 w. Eng News—Sept. 10, 1903. No. 57823.

The Ayer & Lord Tie Co.'s Carbondale Preserving Plant. An illustrated detailed description of this Illinois plant, remarkable for its size, structures and arrangements for all the successful processes of preserving timber. 1600 w. R R Gaz—Sept. 11, 1903. No. 57825.

The Operation of the Burlington Tie Treating Plant. F. J. Angier. Illustrated detailed description of the plant at Sheridan, Wyo. 2500 w. Ry Age—Sept. 4, 1903. No. 57745.

TRAFFIC.

Earnings.

Disproportion of Gross and Net Railroad Earnings. Editorial discussion of the returns as published by the *Financial Chronicle*. 1200 w. Ir Age—Sept. 10, 1903. No. 57768.

Tonnage.

The Proper Handling of the Tonnage Rating System. R. S. Wickersham. Discusses points that are important in making tonnage rating a success. 1500 w. Am Engr & R R Jour—Sept., 1903. No. 57660 C.

MISCELLANY.

Crewe.

The Railway Town of Crewe. Charles S. Lake. An illustrated article reviewing the development of the home of the London & North-Western Railway works, describing the shops, which are the largest in the world. 5400 w. Cassier's Mag—Sept., 1903. No. 57937 B.

Ireland.

Some Early Irish Railroads. W. B. Paley. Brief historical review. 1500 w. R R Gaz—Sept. 11, 1903. No. 57826.

STREET AND ELECTRIC RAILWAYS

Accounting.

Census Statistics and the Standard form of Electric Railway Accounting. William M. Steuart. A discussion of the difficulties attending a uniform application of a system of accounts. 8000 w. St Ry Rev (Daily Ed)—Sept. 4, 1903. No. 57802 C.

Purchasing and Accounting for Supplies on Electric Railway Systems. W. H.

Staub. Explains the system used by the United Railways & Electric Co. of Baltimore, Md. 2800 w. St Ry Rev—Aug. 21, 1903. No. 57622 C.

Albany.

United Traction System of Albany. An illustrated description of the line, its equipment and management. 4800 w. St. Ry Jour—Aug. 29, 1903. No. 57669 D.

Car Bodies.

Care and Maintenance of Car Bodies. C. F. Baker. The writer's views from experience in meeting the conditions at Boston. General discussion. 9500 w. St Ry Rev (Daily Ed)—Sept. 2, 1903. No. 57799 C.

Car Houses.

The Application of Mill Construction to Car Houses. J. O. DeWolf. An illustrated detailed description of this construction, showing its advantages. 1800 w. St Ry Rev—Aug. 20. 1903. No. 57-621 C

Claim Department.

I. The Machinery of the Claim Adjusting Department. T. E. Mitten. Describes in detail the method of reporting accidents and adjusting claims in vogue on the system of the International Ry. Co. of Buffalo. II. The Successful and the Unsuccessful Claim Agent. Dr. H. B. Rockwell. Analyzes the qualifications necessary. 4700 w. St Ry Rev—Aug. 20, 1903. No. 57620 C.

Controllers.

The Use and Abuse of Controlling Mechanism. D. F. Carver. On the importance of watchfulness, care and systematic inspection. General discussion. 4500 w. St Ry Rev (Daily Ed)—Sept. 4, 1903. No. 57805 C.

"Type M" Control. W. O. Mundy. Brief description, with remarks on the uses of this controller and its advantages. Short discussion. 2400 w. St Ry Rev (Daily Ed)—Sept. 3, 1903. No. 57801 C.

Direct Currents.

The Transmission of a 23,000-Volt Direct Current Over a Distance of Thirty-five Miles. Emile Guarini. Illustrates and describes the hydro-electric plant at St. Maurice, near Lausanne, Switzerland. 1800 w. Sci Am Sup—Aug. 29, 1903. No. 57617.

Economics.

Possible Economies in Central Station and Distribution Systems. Philip Dawson. A résumé of current practice in power station operation, discussing the problem of economical production and distribution of electrical energy. 4500 w. St Ry Jour—Aug. 29, 1903. No. 57676 D.

Electric Traction.

Electric Traction on Railways. Br. Bohm-Raffay. From *Zeitschrift des Ingenieur- und Architekten Vereines.* Describes briefly the experimental roads in Germany and Switzerland, for the running at high speeds, giving details of the system adopted by the Maschinenfabrik Oerlikon. 4600 w. Bul Internat Ry Cong—Aug., 1903. No. 57813 E.

English Tramways.

Lowestoft Municipal Electric Tramways. Illustrated detailed description. 3000 w. Tram & Ry Wld—Sept. 3, 1903. No. 57846 B.

Reading Corporation Electric Tramway. Illustrated detailed description of this road and its equipment. 10800 w. Tram & Ry Wld—Sept. 3, 1903. No. 57845 B.

Feeder Calculations.

Feeder Calculations for Direct Current Railways. William A. Del Mar. Considers four typical cases which show the most important distributions of copper and current. 2800 w. Elec Wld & Engr—Aug. 29, 1903. No. 57605.

Gasolene.

Gasolene Cars for Interurban Service. Illustrates and describes a gasolene car put in service in Iowa. 2000 w. St Ry Jour—Sept. 19, 1903. No. 57927 C.

Goods Traffic.

Carriage of Goods on Electric Tramways. Alfred H. Gibbings. Abstract of a paper read before the Manchester Soc. of the Inst. of Elec. Engrs. Shows the possibility of cheapening the cost of conveyance by utilizing electric tramways for short distance traffic. 4400 w. Elect'n, Lond—Aug. 21, 1903. No. 57579 A.

Freight and Express on Electric Railways. J. B. McClary. Considers methods of handling freight and express on electric roads, the profits, and related matter of interest. 4800 w. St Ry Jour—Sept. 12, 1903. No. 57888 C.

Interurban.

Fonda, Johnstown and Gloversville system. Illustrates and describes this system which combines both steam and electric operation. 7000 w. St Ry Jour—Aug. 27, 1903. No. 57670 D.

The City and Interurban System of the Schenectady Railway Company. An illustrated survey of this system which has features of more than ordinary interest. 3000 w. Elec Rev, N Y—No. 57601.

The Electric Division of the Fonda, Johnstown & Gloversville Railroad. H. O. Rockwell. Illustrates and describes the line and its equipment. 10000 w. St Ry Rev—Aug. 20, 1903. No. 57625 C.

The Hudson Valley Railway. An illustrated article describing this system and its points of interest. 3800 w. St Ry Jour—Aug. 29, 1903. No. 57668 D.

The West Penn Railways and Lighting System. An illustrated detailed description. 7800 w. St Ry Jour—Sept. 5, 1903. No. 57808 C.

Intramural Railway.

The Intramural Railway for the St. Louis World's Fair. Two illustrated articles by Richard H. Phillips, and by Charles V. Weston. The first is descriptive; the second discusses the original design, with estimates on performance and cost. 3300 w. St Ry Rev—Aug. 20, 1903. No. 57618 C.

London.

London United Electric Tramways. B. Pontifex. An illustrated detailed description of the power-house equipments, and the cars and overhead construction work, etc. 3300 w. Elec Engr, Lond—Aug. 21, 1903. No. 57572 A.

The Central London Railway. H. F. Parshall, E. Parry, and W. Casson. The present article gives an illustrated detailed description of the later type of motor cars which are now in service. 1700 w. Trac & Trans—Sept., 1903. Serial. No. 57852 E.

The Question of Tramways for London. W. Craig Henderson. Considers the traffic conditions of Central London and thinks the narrowness of the streets makes rapid tramway communication in that part of the city impracticable. 5000 w. Trac & Trans—Sept., 1903. No. 57847 E.

Massachusetts.

Expansion of Electric Railways in Massachusetts. Alton D. Adams. A review of the returns for 1901, showing the remarkable development. 1500 w. Sci Am—Sept. 19, 1903. No. 57889.

New South Wales.

Electric Traction in Sydney, New South Wales. Arthur C. W. Webb. An illustrated detailed description. 3300 w. Elec Wld & Engr—Aug. 29, 1903. No. 57602.

New System.

Tangential Traction. An explanation of a new system of electric traction invented by two young Russian engineers, and based upon the direct application of polyphase currents. 2400 w. Elec Rev, Lond—Aug. 21, 1903. Serial. 1st part. No. 57575 A.

New York City.

Report of the Merchants' Association on Improving the Surface Car Service of New York City. Abstracts such features of the report as are of general interest 6000 w. Eng News—Sept. 17, 1903. No. 57947.

Report of the New York Rapid Transit Commissioners. An illustrated review of the second report of the Board, for the year ending Dec. 31, 1902. 4000 w. R R Gaz—Sept. 4, 1903. No. 57791.

Section Seven, Division Three, of the New York Rapid Transit Railroad. An illustrated description of the work on this section almost wholly in tunnel excavation through micacous rock, and having dufficulties due to the irregularity of the ground and obstructions at various points. 4200 w. Eng Rec—Sept. 19, 1901. No. 57935.

Overhead Construction.

Standard Overhead Construction in City Streets. An illustrated outline of the practice in the largest cities of the United States, with general conclusions. 2700 w. St Ry Jour—Aug. 29, 1903. No. 57673 D.

Paris Underground.

The Metropolitan Underground Railway of Paris. Illustrates and describes the construction of the North Circle. 3000 w. Eng News—Sept. 3, 1903. No. 57790

Power Equipment.

Power Equipment for City Roads. An illustrated article, showing the general condition of power equipment of American cities. 3200 w. St Ry Jour—Aug. 27, 1903. No. 57675 D.

Remittances.

The Advantages and Disadvantages of the "Bag System," as Compared with the "Receiver System" of Handling Conductor's Remittances. Frank R. Henry. Considers the comparative advantages and disadvantages of the two systems. 4400 w. St Ry (Daily Ed)—Sept. 4, 1903. No 57803 C.

Repair Shop.

Modern Repair Shop Methods. Richard McCulloch. An illustrated description of the equipment, operation and methods of the repair shop of the Chicago City Ry. and giving much valuable information. 4800 w. St Ry Jour—Aug. 29, 1903. No. 57677 D.

Rolling Stock.

Standard Practice in Rolling Stock for City Service. Illustrates and describes the types of cars, showing the tendency to increase the length and weight, and the growing popularity of the semi-convertible car. 6500 w. St Ry Jour—Aug. 29, 1903. No. 57674 D.

Running Powers.

Running Powers Over Tramways. Vincent R. Balfour-Browne. Discusses cases in England where running powers have been granted to one company to run over and use the stations of another company. 3000 w. Trac & Trans—Sept., 1903. No 57848 E.

Schenectady.

Schenectady's City, Suburban and Interurban Electric Railway Facilities. An illustrated description of rapid advancement in the electric railway industry. 5800 w. St Ry Jour—Aug. 29, 1903. No. 57671 D.

Shops.

Shop Practice. Alfred Green. The writer's experience, describing the plant of the Rochester Ry. Co. and the practices in vogue. Ill. 8500 w. St Ry Rev (Daily Ed)—Sept. 3, 1903. No. 57800 C.

Signaling.

Automatic Electric Railway Signaling; Its Purposes; Also Past and Present Installations. C. C. Rosenberg, and H. S. Balliet. Shows the method of installation and apparatus from the inception of automatic signaling, the improvements made, etc. 8000 w. Jour Fr Inst—Sept., 1903. No. 57974 D.

Single-Phase.

A New Single-Phase System of Electric Traction. Brief illustrated description of the Westinghouse installation for the Baltimore, Washington & Annapolis Electric Ry. 2000 w. St Ry Rev—Aug. 20, 1903. No. 57619 C.

Surface Contact.

Electric Traction by the Schuckert System of Superficial Contacts. Emile Guarini. Brief illustrated description, with statement of advantages claimed. 500 w. Sci Am Sup—Sept. 26, 1903. No. 57962.

Schuckert Surface-Contact Street Railway System. S. N. Taylor. An illustrated description of an experimental street railway, known as the "Contact Knob" system. 1200 w. Elec Wld & Engr—Aug. 29, 1903. No. 57603.

Surface Contact Systems on the Paris Traction Lines. C. L. Durand. Illustrates and describes two of the leading systems. 3500 w. Elec Rev, N. Y.—Sept. 5, 1903. No. 57759.

The Slot-Conduit System and the Schuckert Surface-Contact System. A comparison of working expenses of the Brussels and Paris slot-conduit systems, with the surface-contact system named, to the advantage of the latter. 3500 w. Elec Engr, Lond—Aug. 21, 1903. No. 57573 A.

Sweden.

The Adoption of Electric Traction on the Swedish State Railways. R. Dahlander. Abstract of a report made to determine whether electric traction was advisable under the conditions existing, and the limited traffic. 5300 w. Bul Internat Ry Cong—Aug., 1903. No. 57811 E.

Third Rail.

The Third-Rail System. L. E. Gould. Discusses details of the system. 3000 w. St Ry Rev—Aug. 20, 1903. No. 57623 C.

Third Rail System of the Albany & Hudson Railroad Co. R. P. Leavitt. Brief illustrated description of this line which carries passengers and freight between Albany and Hudson. 2000 w. St Ry Rev—Aug. 20, 1903. No. 57626 C.

Toledo.

The Toledo Railway and Terminal Company. Map and illustrated description of the lines and equipment of this company. 1800 w. Ry Age—Sept. 11, 1903. No. 57875.

Tracks.

Standard Practice in City Track Construction. An illustrated article outlining the standard practice of the largest cities in the United States. 7200 w. St Ry Jour—Aug. 29, 1903. No. 57672 D.

Trolley Omnibuses.

Electric-Trolley Omnibuses. Illustrated description of the most recent designs and their equipment. 1000 w. Elect'n, Lond—Aug. 21, 1903. No. 57578 A.

Electric Trolley Vehicles without Rails. Emile Guarini. An illustrated account of the application of trolley traction to ordinary highways, and its adaptability to lines of light traffic density. 4000 w. Engineering Magazine—Oct., 1903. No. 58083 B.

Overhead Traction for Road Vehicles. An illustrated description of the Stoll electric omnibus system. 1600 w. Elec Rev, Lond—Sept. 11, 1903. No. 57902 A.

The Lombard-Gerin Trolley Omnibus. Illustrates and describes briefly a type where the connection between the car and overhead wires is by a flexible cable. 1500 w. Elec Times—Sept. 10, 1903. No. 57874 A.

Trackless Tramways (Ueber Gleislose Bahnen). Max Stobrawa. A discussion of the commercial possibilities of electric traction without rails, using the overhead trolley and motor omnibuses upon ordinary highways. 6000 w. Elektrotech Zeitschr—Aug. 27, 1903. No. 58063 B.

Trolley Wire.

The Overhead Conductor of the Hagen Tramways (Die Profildraht Oberleitungsanlage der Hagener Strassenbahn). H. Welter. Describing the use of trolley wire of the hour glass section, including the method of supporting and operating with the bow trolley. 1800 w. Elektrotech Zeitschr—Aug. 13, 1903. No. 58054 B.

EXPLANATORY NOTE—THE ENGINEERING INDEX.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* Boston.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Jl. of Science. *m.* New Haven, U.S.A.
American Machinist. *w.* New York.
American Shipbuilder. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. d Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *qr.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Sydney.
Autocar. *w.* Coventry, England.
Automobile. *m.* New York.
Automobile Magazine. *m.* New York.
Automotor & Horseless Vehicle Jl. *m.* London.
Beton und Eisen. *qr.* Vienna.
Brick Builder. *m.* Boston.
British Architect. *w.* London.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bulletin American Iron and Steel Asso. *w.* Philadelphia, U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. Soc. Int. d Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Montreal.
Canadian Mining Review. *m.* Ottawa.
Cassier's Magazine. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Electrical Engineer. *w.* London.
Electrical Review. *w.* London.

Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Electrochemical Industry. *m.* New York.
Electrochemist and Metallurgist. *w.* London.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Chicago.
Engineering. *w.* London.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penna. *m.* Pittsburg, U.S.A.
Feilden's Magazine. *m.* London.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland, U. S. A.
Gas Engineers' Mag. *m.* Birmingham.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e. d. Str. Ferr. *w.* Rome.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Ice and Refrigeration. *m.* New York.
Ill. Zeitschr. f. Klein u. Strassenbahnen. *s-m.* Berlin.
Ingeneria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron and Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. Am. Foundrymen's Assoc. *m.* New York.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Journal of Sanitary Institute. *qr.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery *b-m.* Fort Monroe, U.S.A.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U.S.A.
Locomotive. *m.* Hartford, U. S. A.
Locomotive Engineering. *m.* New York.
Machinery. *m.* London.
Machinery. *m.* New York.
Madrid Cientifico. *t-m.* Madrid.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Metallographist. *qr.* Boston.
Metal Worker. *w.* New York.
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* City of Mexico.
Minerva. *w.* Rome.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci Press. *w.* San Francisco.
Mining Reporter. *w.* Denver, U. S. A.
Mitt. aus d Kgl Tech. Versuchsanst. Berlin.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Modern Machinery. *m.* Chicago.
Monatsschr. d Württ. Ver. f. Baukunde. *m.* Stuttgart.
Moniteur Industriel. *w.* Paris.
Mouvement Maritime. *w.* Brussels.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *m.* New York.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Nineteenth Century. *m.* London.
North American Review. *m.* New York.
Oest. Wochenschr. f. d. Oeft Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg- & Hüttenwesen. *w.* Vienna.
Ores and Metals. *w.* Denver, U. S. A.
Pacific Coast Miner. *w.* San Francisco.
Page's Magazine. *m.* London.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Procedings Engineers' Club. *qr.* Philadelphia.
Pro. St. Louis R'Way Club. *m.* St. Louis, U. S. A.
Progressive Age. *s-m.* New York.
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago
Review of Reviews. *m.* London & New York.
Revista d Obras. Pub. *w.* Madrid.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Gen. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Engng. *m.* Ithaca, N. Y.
Stahl und Eisen. *s-m.* Düsseldorf.
Steam Engineering. *m.* Chicago.
Stevens' Institute Indicator. *qr.* Hoboken U.S.A.
Stone. *m.* New York.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago.
Tijds. v h Kljk. Inst. v Ing. *qr.* Hague.
Traction and Transmission. *m.* London.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining. Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
Wiener Bauindustrie Zeitung. *w.* Vienna.
World's Work. *m.* New York.
Yacht. *w.* Paris.
Zeitschr. d. Mitteleurop. Motorwagen Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a S.
Zeitschr. f. Electrotechnik. *w.* Vienna.

CURRENT RECORD OF NEW BOOKS

Note—Our readers may order through us any book here mentioned, remitting the publisher's price as given in each notice. Checks, Drafts, and Post Office Orders, home and foreign, should be made payable to The Engineering Magazine.

Alloys.

Iron, Steel, and Other Alloys. By Henry Marion Howe, Professor of Metallurgy in Columbia University in the City of New York. Size 9 by 6 in.; pp. xviii, 457; plates and illustrations in the text. Price, $5.00. Boston: Sauveur & Whiting.

The high authority which is associated with the writings of Professor Howe renders this latest work upon his especial subject one of much value. At the present time the older views as to the nature of the various forms of iron and steel are being modified by the revelations of the study of the physical character by the methods of metallography, and to-day the microscope and the photographic camera have become the working tools of the metallurgist. The present book was originally prepared for the use of students, supplementing instruction by lectures and other reading, but it has been extended beyond these limits by being made to include an account of the solution theory, by which it is sought to explain the facts revealed by the methods of metallography. Taking up first the analogy of metals and alloys to rocks, when examined under the microscope, the nature of solid solutions and their resemblance to liquid solutions is discussed, and the study of cooling and freezing curves taken up. This is followed by a discussion of binary alloys, either as forming no definite chemical compounds, or as combining chemically as well as forming solutions. The relation of electrical conductivity to physical constitution, as well as the other properties of the series of alloys, follow, all this forming really an introduction to the study of iron and steel considered as alloys composed of several constituents. The application of the methods of metallography to the study of these combinations and solutions are very fully discussed, and numerous illustrations from microphotographs are given, together with their interpretation. As a consequence of this theoretical study of the facts determined from the examination of the iron-carbon alloys which form what we know as steel and iron, there follows a practical discussion of the processes of affecting the properties of those alloys by the influence of heat, and the important subject of the heat-treatment of steel forms one of the most valuable portions of the work to the engineer. A knowledge of the reasons why the structure of a steel can be controlled by heat-treatment must influence to a marked degree the operations involved in processes of manufacture and working, and there is every reason to believe that the period of empiricism in this fundamental subject has passed, to be replaced by an intelligent application of determinate scientific principles. The so-called "phase rule," by means of which the probable stability of an alloy may be discovered, is clearly explained, and the work concludes with chapters upon the practical manufacture of iron and steel, including a study of blast furnaces, steel furnaces, and gas producers.

Book-Keeping.

The Science of Loose-Leaf Book-Keeping and Accounting. By Chas. A. Sweetland, Public Accountant. 7¾ by 5½ in.; pp. 238; forms, 48. Price, $2. St. Louis: Chas. A. Sweetland.

Loose-leaf book-keeping is a natural outgrowth of card indexing, and, like the latter, has developed rapidly within recent years. Its great advantages cannot fail to be recognized by an unprejudiced mind, and it is sure to supplant, in a large measure, the older methods of keeping records in permanently bound books. It is now generally understood that the term "loose leaf," as applied to book-keeping, or the keeping of records of any kind, means the use of books in which leaves may be inserted and from which leaves may be removed with entire freedom, as distinguished from bound books in which the leaves are permanently fixed. Flexibility, elasticity, economy of book space, saving of time, preservation of all old accounts with complete ease of reference, combined with the convenient handling of current accounts unencumbered with dead matter, are some of the advantages of the loose-leaf system, the knowledge of which is fast increasing, but is not yet as widespread as it should be, partly owing to the lack, heretofore, of a work dealing with the whole subject. The volume under consideration presents the matter in convenient and convincing form, and treats the subject of loose-leaf book-keeping with the authority of a trained and experienced accountant, entirely conversant with the old as well as the new methods. Any one interested in accounting will be well repaid by a perusal of this book, for it will not only enlighten those who are still keeping books in the old way, but will also show the users of new methods how to derive the utmost benefit from the loose-leaf system.

Electric Railways.

Engineering Preliminaries for an Interurban Electric Railway. By Ernest Gonzenbach. Size, 9 by 6 in.; pp. 71; figures, 6. Price, $1. New York: McGraw Publishing Company.

The extension of interurban electric railways has gone on at such a rate that standardization in their design and construction has not had time to become fixed, and the roads now in operation exhibit all degrees of practice from that of horse-car lines to that of first-class steam railways. A systematic analysis of the conditions of a particular case, and an account of the methods proposed to meet those conditions, are, therefore, of great practical interest, and are given in the present volume, which is an amplification of a report on a projected railway in the middle west of the United States, this railway being a good example of some roads already built and many more still on paper. The plans for this road are discussed from both financial and engineering standpoints, and practical reasons are given for the designs recommended, the style of the book being so direct and clear that it appeals no less to the railway promoter than to the engineer.

Marine Engines.

Detail Drawings of a Four-Furnace Single-End Scotch Boiler, together with Diagrammatic Pipe and Auxiliary Plan Used in Connection with a Triple-Expansion Engine, and a 1,250-H. P. Triple-Expansion Engine, with Key Naming and Describing Every Part of the Engine. Three sheets of drawings and explanatory text. Price, $1. New York: Marine Engineering.

In issuing these reprints from *Marine Engineering*, the publishers have put some valuable information in convenient and accessible form where it will prove very useful to the marine-engine designer and to the student of marine engineering. The sheets of drawings come in a neat cover and are accompanied by two pages of text describing the standard forms of marine steam plants, and containing a key to the diagrammatic pipe plan.

Mechanical Engineer's Pocket-Book.

The Mechanical Engineer's Pocket-Book of Tables, Formulæ, Rules and Data. A Handy Book of Reference for Daily Use in Engineering Practice. By the late D. Kinnear Clark, M. Inst. C. E. Fifth Edition, Revised Throughout and Enlarged by H. H. P. Powles, M. I. M. E., A.-M. Inst. C. E. Size, 6 by 3¾ in.; pp. xxxii, 692; figures, 96. Price, $3 (6s.). New York: D. Van Nostrand Company London: Crosby, Lockwood and Son.

Clark's "Manual" has long been one of the standard engineering books of reference, but its size prevents it from being conveniently carried about so as to be always ready for consultation, and, in addition, much of its material is not in a form which is best adapted to the everyday needs of mechanical men. For these and other reasons, the late Mr. Clark prepared a pocket-book, compiled expressly to meet the practical requirements of the mechanical engineer, of which the present is the fifth edition. Mr. Clark's death having occurred a few years ago, this edition has been edited by Mr. H. H. P. Powles, and the opportunity has been taken advantage of to carefully revise and correct the work throughout, without, however, interfering with the original plan of Mr. Clark. The section dealing with electrical engineering has been largely re-written, with additions, so as to adapt it to recent developments. The revised electrical wiring rules issued by the Institution of Electrical Engineers are reproduced in their entirety. In other sections, also, new matter has been added as required, thus bringing the work thoroughly up to date, and maintaining its character as a faithful presentation of modern every-day practice.

Mineral Industry.

The Mineral Industry, Its Statistics, Technology and Trade in the United States and Other Countries to the End of 1902. Vol. XI. Founded by the late Richard P. Rothwell. Edited by Joseph Struthers, Ph. D. Size, 9½ by 7 in.; pp. xxx, 891; illustrations, figures and tables. Price, $5 (£1, 10d.). New York and London: The Engineering and Mining Journal.

Each year the appearance of this work is looked forward to with eagerness by the mining and metallurgical world, and it never fails to meet expectations. To say that the present volume sustains the high reputation of its predecessors is to indicate its great value and interest, which will be even more apparent upon a closer examination. As is well known, this work contains statistics of the production and prices of minerals and metals in all countries, brought up to date and made as complete as possible. The figures are usually far in advance of government publications, but they are obtained from government records and from other authoritative sources. Besides these statistics, there are reviews of the technical progress made in the metallurgical industries throughout the year, and descriptions of new processes. In general arrangement, the book follows the lines established in its predecessors: The various mineral and metal products are taken up in alphabetical order and discussed from both technical and commercial standpoints, different sections under each general heading being treated by experts in many parts of the world. In addition, there are special chapters on various subjects, each by an authority in his own field. Among such topics in the present volume may be mentioned: Electrochemistry and electrometallurgy; manufacture of mineral wool; rare elements; literature of ore deposits; ore dressing; metallography; alloy steels; pyritic smelting; manufacture and use of titanium and similar alloys; concentration of ores by oil; and sampling and estimation of ore in a mine. There are also statistics of the mining stock exchanges in 1902, a general summary of the import duties of the principal countries of the world, and a comprehensive index. In fact, this work, which has now become practically an annual cyclopedia of the mineral and metal industries of the world, can hardly be dispensed with by any one interested in mining and metallurgy.

Mine Ventilation.

Ventilation in Mines. By Robert Wabner. Translated from the German by Charles Salter. Size, 10 by 6¾ in.; pp. xi, 240; figures, 114; plates, 30. Price, 10s. 6d. ($4.50). London: Scott, Greenwood & Co. New York: D. Van Nostrand Company.

Many years have elapsed since the labors of Guibal for the improvement of mine ventilation, which were so rich in practical results, and in the meantime great progress has been made in improving the air supply of underground workings, and with an increase of knowledge, opinions concerning the dangerous gases occurring in mines have undergone considerable modification. There is, therefore, ample justification for the appearance of a new treatise on mine ventilation, such as the present work, which considers the subject from a modern point of view. This volume covers the ground pretty thoroughly, and besides discussing the theoretical questions involved, it describes and illustrates a great deal of the latest apparatus and many of the recent methods adopted. The description of respiration and rescue apparatus is particularly good. Among the other topics treated may be mentioned: The causes of the contamination of the air of mines; the means of preventing the dangers resulting from this contamination, including the testing of firedamp and firedamp indicators; calculating the volume of ventilating current necessary to free mine air from contamination, with descriptions of pressure gauges and anemometers; determination of the resistance opposed to the passage of air through the mine, with the laws of resistance and formulæ therefor; means for providing a ventilating current; mechanical ventilation; ventilators and fans; the theoretical, initial and true depression of the centrifugal fan; new types of centrifugal fan of small diameter and high working speed; the utilisation of the ventilating current to the utmost advantage and its distribution through the workings; the artificial retardation of the ventilating current; ventilating preliminary workings; blind headings; separate ventilation; and supervision of ventilation. There are many clear illustrations in the text and on plates, and an index completes a very useful and valuable work.

Pattern Making.

The Art of Pattern-Making. A Comprehensive Treatise. Numerous Examples of all Kinds of Pattern Work for Green-Sand, Dry-Sand, and Loam Moulding. Pattern Work for Marine Engines and Screw Propellers. Also, Useful Information and Rules for the Practical Use of Pattern Makers and Others. By I. McKim Chase, M. E. Size, 7½ by 5 in.; pp. vi, 254; figures, 215. Price, $2.50. New York: John Wiley & Sons. London: Chapman & Hall, Limited.

The literature pertaining to pattern-making is not as extensive as the importance of the subject warrants, and is for the most part scattered through the pages of technical periodicals, so that a systematic treatise, such as the present book, by a man experienced in the art, will prove very acceptable to the whole craft of pattern makers. The subjects chosen for illustration in this work are chiefly those with which the author has had personal experience and were originally written for publication in *Machinery*. He also records the experience of others in pattern-making, examples being selected principally from the correspondence of the *American Machinist*, and embodying whatever in his opinion would be of most interest to the pattern-making fraternity. Providing for the interior of castings, or core-box work, is correctly regarded as the most intricate and important part of pattern-making, and so there are several excellent examples of core-box work described. A great deal of attention is devoted to pattern work for screw propellers, and different methods of moulding various styles are discussed. Besides giving numerous specific examples of pattern-making, the book contains chapters on subjects of general interest, such as glue and its use, marking, recording and storing patterns, handy tools for pattern makers, shrinkage rules and mensuration, and a great deal of other practical information.

Resistance of Materials.

The Elasticity and Resistance of the Materials of Engineering. By Wm. H. Burr, C. E. Sixth Edition. Size, 9 by 6 in.; pp. xv, 1070; many illustrations and figures. Price, $7.50. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

Prof. Burr's "Resistance of Materials" has been so long and so favorably known to engineers and students that a new edition of his work is an event in the engineering world. The present edition constitutes almost a new book, one-half or more of the volume being fresh matter, and the general arrangement has also been considerably changed, so as to make it even better adapted than before to serve the double purpose of a work of reference and a text book. As steel has completely displaced wrought iron for structural purposes, this metal as used under all conditions for structures or machines is given extended consideration, including the effects of chemical constitution and shop manipulation. The physical properties of the new steels, such as nickel and manganese steels, are fully given. The same observation applies to aluminum, copper, tin, zinc, and their alloys. There is a remarkably full presentation of all the physical properties, both elastic and ultimate, of the modern Portland-cement mortars and concretes, including beams of those materials. The latest investigations regarding the elastic and ultimate resistances of stone and masonry columns and beams are completely set forth. One of the most important sections of the book is that relating to concrete-steel members. The use of reinforced-concrete is increasing very rapidly, and while there have been various papers and articles dealing with the subject, this is probably the first time in the English language that this class of construction has been systematically and completely treated. A most valuable practical feature is the full set of tables and cuts of rolled shapes taken from the handbook of the Cambria Steel Company. The book is a remarkably complete treatment of all those theoretical and practical questions relating to the great field of application of all classes of engineering materials, in such a way as to be of the most direct value both to the practicing engineer and to the engineering student.

Steel Working.

The American Steel Worker. A Twenty-Five Years' Experience in the Selection, Annealing, Working, Hardening and Tempering of Various Kinds and Grades of Steel. By E. R. Markham. Size, 8 by 6 in.; pp. 343; figures, 160. Price, $2.50. New York: The Derry-Collard Company.

The introduction of the new high-speed steels for cutting tools has aroused fresh interest in the question of the treatment of steel, and has emphasized the importance of the condition of the various tools used in machine-shop work. In order to get satisfactory results from his tools, a mechanic must know something about their nature and a great deal about the proper method of handling them. Such knowledge is given in plain language, with many clear and up-to-date illustrations, in the present book. All the different kinds of work in the treatment and handling of steel which are likely to be encountered by a workman are discussed and described in a very practical manner, which shows the results of long experience. The volume has a complete index, and will be found very useful to all who are concerned with the working of steel.

BOOKS RECEIVED.

Principles of American Forestry. By Samuel B. Green. Price, $1.50. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

Yearbook of the United States Department of Agriculture, 1902. Washington, D. C.

Jahrbuch für das Eisenhüttenwesen. Ergänzung zu *Stahl und Eisen*. By Otto Vogel. Price, 10 marks ($3.35). Düsseldorf: August Bagel.

Proceedings of the Fourth Annual Convention of the American Railway Engineering and Maintenance of Way Association, held at the Auditorium Hotel, Chicago, Illinois, March 17, 18 and 19, 1903. Published under direction of the Committee on Publications. Secretary of the Association: L. C. Fritch, Monadnock Block, Chicago.

New Instruments of Precision from the Ryerson Laboratory. By R. A. Millikan. Price, 25 cents. Chicago. The University of Chicago Press.

Moderne Gesichtspunkte für den Entwurf Elektrischer Maschinen und Apparate. By Dr. F. Niethammer. Price, 8 marks ($2.50.) Munich and Berlin. R. Oldenbourg.

Specifications for Portland and Natural Cements and Portland-Cement Concrete. Price, 10 cents. Published by the American Railway Engineering and Maintenance of Way Association, Monadnock Block, Chicago.

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"THE WORLD IS ITS FIELD"

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RAILWAY MAKING IN CHINA.

By Thos. H. Reid.

The crux of the complications in the Far East is the competition for opportunity to exploit the almost untouched resources of the Chinese Empire. It is anomalous that the largest factor in the field, so far as the northern provinces are concerned, should be Russia—a country wholly unprepared to supply the engineering equipment and promote the industrial development which have always accompanied Anglo-Saxon influence in new lands. It is of interest therefore, at a time when so much is heard of Russian aims in north-eastern Asia, to contrast her record with the character and spirit of the work actually done by Americans and Englishmen in South China.—The Editors.

All recent writers are agreed that one of the most pressing needs of China, politically, strategically, and commercially, is the means of rapid transit. Already falling into disrepair or taxed to their utmost capacity in congested areas, the wonderful waterways of the country do not provide those facilities which are necessary for the development of China's potential resources. Travel by shallow rivers and canals is invariably slow, often dangerous. Days and weeks are consumed in penetrating the interior, and large tracts of country far distant from the centres of population are uncultivated, or lie with their mineral treasures untouched because of the lack of communication. Thousands starve annually in one province while there is an abundant harvest in an adjacent province—merely because transport, at all times difficult, becomes impossible at times of famine. The import trade of China is restricted because the cost of transit added to the native customs levies makes it impossible for foreign goods to penetrate to the far distant interior; the export trade is limited in like manner and the purchasing power of the people thereby reduced. It is claimed by the advocates of railways that improved communication would enable the central government to exercise more efficient control of the provinces, would enable the officials to put down rebellious movements in their incipient stage, give the government the ability to concentrate quickly masses of men upon threatened points in times of war, distribute the people from congested to less populous provinces, provide facilities for famine relief, develop inter-provincial trade, and create channels for the distribution at cheap rates of foreign goods entering at the treaty ports.

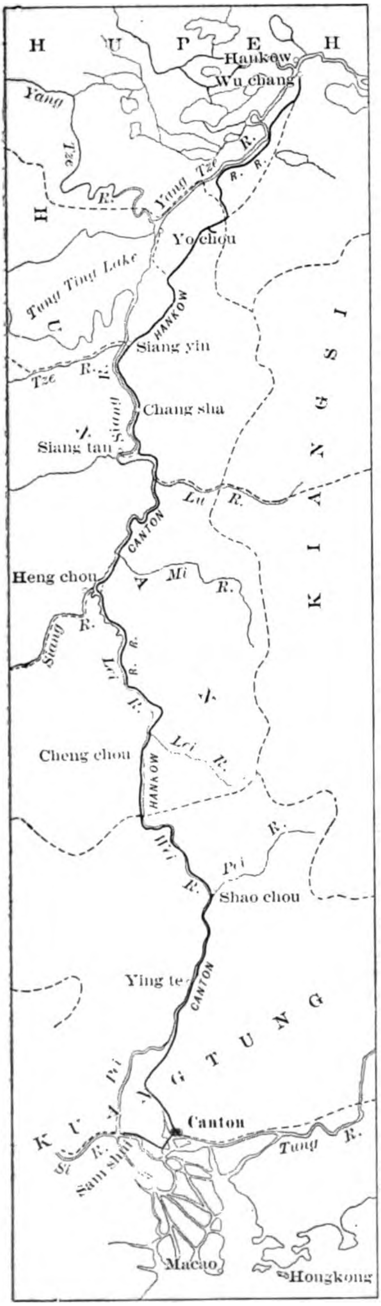
In his excellent work "China in Transformation," Mr. A. R. Colquhoun, who knows China thoroughly, thus sums up the case for railways:—

> "The importance of rapid, direct, and practicable communications, that would enable the Chinese to develop the resources of their territories, and to open through communication with their neighbours, thus providing new arteries of commerce, is an axiom which should need no demonstration. These communications should satisfy industrial and commercial interests, while meeting political and administrative necessities. In the present deplorable condition of China (he was writing in 1898), no measure can render her greater service than the introduction of railways. 'Steam or Anarchy,' as Williamson said thirty years ago, are the only alternatives left to the Chinese people."

It is not my intention to discuss how it is that a people so practicable, possessing a high class of shrewdness, intelligence, and adaptability, and, above all, so thoroughly imbued with the commercial instinct, should be so backward in this matter of communications. The fact remains that of all civilised peoples the Chinese are the most backward as a race in the application to daily uses of modern mechanics; but it may be regarded as a hopeful augury that they are awakening to a sense of their own backwardness, and at the treaty ports are not slow to abandon their cumbrous native boats for the more mobile steam launch, which, if more expensive at the beginning, rapidly repays its owner for his enterprise. Advocates of the railway find in this a proof that the Chinaman will avail himself readily of better means of travel than is now available, and the experience in North China is certainly in their favour; for in 1897 Mr. Colquhoun found the new means of conveyance so much in favour that crowds were travelling to and fro for the mere novelty of the thing.

Devoting myself entirely to the railways of South China, it may be remarked *en passant* that the first railway laid down in China was a small line connecting Shanghai and Woosung. It was constructed in 1876 with British capital, was sold a year later to the Chinese local authorities, and taken up by them, because of the hostility of the natives, and the material used in Formosa and North China. A small line was then constructed from the Kaiping coal mines, in the neighbourhood of Tientsin, to the Petang River, gradually growing to a very excellent line of over 300 miles in length, and now it is possible to travel from Peking to Port Arthur (the new Russian naval and military base in the Gulf of Pechili) and thence to Europe by the Eastern Chinese Railway in Manchuria and Russia's great strategical line in Siberia. Various railway projects are on foot in North China and in the Yangtsze Valley, but the most important of all is the Luh Han Railway, now in course of construction by a Belgian syndicate. It will join Peking with Hankow, the great industrial city at the junction of the Han River with the Yangtsze-Kiang, and forms the northern portion of the Grand Trunk Line of China. South of the Yangtsze, the principal project is the Yeun Han Railway, which will connect Wuchang (the southern complement of Hankow) with Canton, thus completing the Grand Trunk, and giving, when constructed, through railway communication practically from Hongkong to Calais by Hankow, Peking, Port Arthur, Harbin, Irkutsk, Moscow, Warsaw, Berlin, and Paris. Between Canton and Samshui, the latter a recently opened treaty port at the junction of the North and West Rivers, there is a branch line supplementing the Yeun Han; and lines are projected between Canton and Macao (the ancient Portuguese colony in the Pearl River delta) and between Canton and Hongkong. The concession for the latter, which would be about 100 miles long, is held by British capitalists.

Canton, the southern metropolis of China, is situated on the left bank of the Pearl River. It was here that foreign traders first came into close relations with the Chinese. Intercourse in the early days was not always of a pleasant or peaceable nature, but in recent years the Cantonese, who are the most enterprising of all the Chinese, have become more reconciled to the *fan-kwei* or "foreign devil." Including those who live in boats on the river, Canton is reputed to have a population of 2,500,000 souls. The city is a perfect hive of industry, if a somewhat noisome and unsavoury one, and is in constant touch with the surrounding towns and villages, mainly by the waterways of the delta. At the western end of the city is the suburb of Wong Sha, where the terminal station and southern headquarters of the Yeun Han Railway will be established. At present the site is occupied by the offices of the American China Development Co., by which the main line and the branch line from Canton to Samshui are being con-



structed. Shek-wai-tong, on the right bank of the river opposite Wong Sha, will be the headquarters of the branch line. Fatshan, 11 miles away, is styled "the Birmingham of South China," on account of the varied character of its manufactures. It has a population of about 500,000 souls, and Sainam, about 17 miles further west, a population of 50,000. Sainam also has varied manufactures, and is of far more importance than Samshui, three miles beyond, to which the railway has been pushed with a view to shorten the journey between the West River and Canton. Going from Canton to Samshui by a fast steam launch through the creeks the journey occupies at least 3½ hours under favourable conditions, but going by the West River route on a powerful shallow-draft Thorneycroft stern-wheel steamer it takes 12 hours.

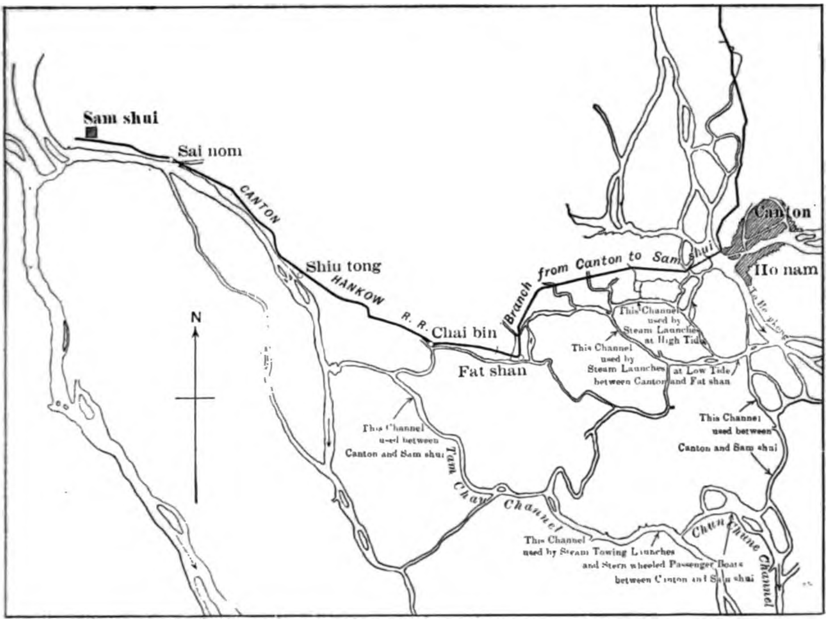
Once away from the delta with its bewildering maze of waterways, the main railway, which I now proceed to deal with in detail, presents no serious engineering difficulties. As will be seen from the accompanying map, it runs almost due north, passing through Yingte (or Yingtak), Shao Chou, Chang Chou, Heng Chou, Chang Sha (the capital of Hunan Province), and Siang Yin to Wuchang. It follows the course of the North River in Kwangtung Province, and crosses the watershed into the Yangtsze Valley by a pass, now designated

"Parsons Gap," 1,000 or 1,200 feet above sea level. This pass was discovered by Mr. Wm. Barclay Parsons, who carried out the original survey for the American Syndicate. It is just to the west of the famous Che-ling pass, over which the tea and other produce from the northern slopes of the mountains used to be carried to the Canton market. Since steamboat traffic developed on the Yangtsze, and Shanghai and the Yangtsze "open ports" have become an important outlet for native produce, the Che-ling pass has been almost entirely abandoned as a trade route; and it is interesting to note in passing that it is strange that a practical people like the Chinese should have continued to use the Che-ling pass for many a century when there was a considerably lower pass at no very great distance on the watershed. The main line can be carried over the mountain on a low gradient. At no point will the gradient be greater than one foot in 125 approximately. It will be a single-track 4 feet 8½ inches gauge with all the characteristics of the Canton-Samshui branch line to be described hereafter. There will be a few tunnels, and fairly heavy rock work for about 100 miles north of Canton, but as there are no roadways in China, only the merest footpaths, no overhead bridges will have to be constructed. The total length will be 750 miles. In 1904 it is intended to construct 150 miles from Canton northwards and 150 miles from Wuchang southwards, and it is anticipated that the whole of the main line will be finished in January, 1906. None of the bridges would be considered long by engineers, and they are not likely to present any serious difficulties. Standard lengths of steel girders will be utilised, and cement concrete for abutments and piers. From Canton to Kong-hau, the line passes through rice country; near Yingtak the country is hilly, and there is at various points along the route good mineral land, which the railways will help to develop.

The first 110 miles from Canton have been re-surveyed by what the American engineer calls "locating parties," and two locating parties are at work in the Province of Hunan. It is curious to notice that whereas in the hermit Province of Hunan—the last to open to foreign influence and residence—the officials have done all in their power to render the work of the survey party easy, in the Kwangtung Province, which has been in touch with foreigners for some centuries, there has been a certain amount of active hostility and still more "passive resistance."

There have been no anti-railway riots in Hunan, no attacks upon the surveying parties. At Yuantang, on the North River, in the month of April, there was, on the other hand, a very serious attack upon the surveyors, which might easily have developed into a lamentable tragedy. Some of the villagers in an outlying village near Yuantang objected to the railway passing through or near their village, and they were incited by an old woman to attack the engineers. The old lady beat a gong to attract the natives from the rice fields, and when the petty mandarin attempted to take the gong from her she harangued the mob. With cries of "ta, ta" ("kill, kill") the incensed natives began their onslaught, led by a man with a heavy two-handed sword. The mandarin had a narrow escape of having his head cleft in two, and the survey party had to execute a strategic movement across the river to the village of Yuantang, where they had their camp. The infuriated natives opened fire with muskets from the opposite side, and when the surveyors abandoned their houseboat and sought safety in an adjacent temple, the natives crossed the river and besieged them for four hours. Had they known how helpless the surveying party was, they might easily have rushed the temple and slain the defenders, who had no arms. The villagers of Yuantang had no grievance, and the elders of that village, not wishing to incur the displeasure of the higher officials, were successful in persuading the rioters to return to their own village by a promise to hand over next morning the unwitting cause of the trouble. In the darkness, the surveyors regained their boats, and dropped down the river to Tsing Yuen, and reported the matter to the prefect. In the meantime, Mr. Burns, the first assistant engineer, had gone up the river in a steam launch, and encountered the wreck of the surveying instruments and rods floating down the river. Seeing that some Europeans were in difficulties with the natives but were holding their own on the Yuantang side of the river, he posted back to Canton, whence the U. S. gunboat Callao was despatched. As it happened, the surveyors escaped without hurt, but the incident might well have been more serious.

Ancestral graves prove one of the most serious obstacles to railway making in China, and wherever possible the engineers have avoided them. Sometimes exorbitant prices are demanded for the removal of an ancestor's remains, but through the influence of Chinese interested in the railway something like uniformity has been arrived at, and the average price now paid for a grave is Taels 4 (about 10 shillings). Consideration of native susceptibilities entails additional expenditure, but it may be regarded as a fortunate circumstance that the railway lies some little distance from the towns and villages, for as soon as its economic value is recognised by the people they will doubtless construct connecting roadways on Western principles, with permanent benefit to a country which has trade routes but no roadways. So far, the only preparation for the main line is a large reclamation at Wong Sha, on the Canton side of the river. This will be the site of the southern terminus, but there is an idea of constructing an overhead line from one end of the city to the other, and of continuing the main line to Whampoa, about ten miles further down the river, where wharves and docks could be erected and ocean liners with a draught of 30 feet come up at any state of the tide and load and discharge cargo. Years ago, before Hongkong became a British colony, the P. & O. Co.'s Eastern steamers docked at Whampoa, where the first graving dock in China was built by a Scotchman named Couper. This dock was acquired subsequently and abandoned by the Hongkong and Whampoa Dock Company, Limited, which at the present day controls the whole of the dock business in South China, and has a shipbuilding and repairing establishment capable of undertaking the docking and repair of the largest merchant vessels and warships. It will be a curious turn of affairs if Whampoa should regain its old importance by becoming the port of Canton, and interesting speculations might be made upon its effect on Hongkong.


Sam shui
Sai nom
CANTON
Shiu tong
HANKOW
R. R.
Chai bin
Fat shan
N
Branch from Canton to Sam shui
Canton
Ho nam
This Channel used by Steam Launches at High Tide
This Channel used by Steam Launches at Low Tide between Canton and Fat shan
This Channel used between Canton and Sam shui
Tam Chau Channel
This Channel used between Canton and Sam shui
This Channel used by Steam Towing Launches and Stern wheeled Passenger Boats between Canton and Sam shui
Chun Chune Channel

MAP OF THE LINE FROM CANTON TO SAMSHUI.

I come now to the consideration of the branch line between Canton and Samshui. The large brick station at Shek-wai-tong will have all the usual accommodation for railway officials, passengers, and customs officials. The other principal stations on the line, which will be 31 miles long, will be at Fatshan, Sainam, and Samshui; but small stations with small landing platforms and shelter for passengers will be erected near the more populous villages on the route. Large ferry boats will convey passengers across the river to Wong Sha.

The grading or embankment for this branch line is completed between Shek-wai-tong and Fatshan, the rails partially laid, and all the bridges and culverts well in hand, and it is arranged to open the line for traffic as far as Fatshan in the month of November. In the first ten miles there are thirteen steel-girder bridges and four culverts in the latest type of reinforced-concrete construction. Of the thirteen bridges one is 10 feet long, two 15 feet, five 20 feet, two 60 feet, and three 120 feet long, the latter made up of one 60-foot span and two 30-foot spans in the clear. The bridges are founded on timber piles, and the abutments and piers are of concrete, with granite bridge seats. These bridges are designed to carry 130-ton locomotives, and are the type that will be used in the construction of the main line. The girders are now at Shek-wai-tong, and as soon as the abutments are finished—a matter of a few weeks—the girders will be placed in position. All the girder work is in standard sizes.

The line runs over alluvial deposit, and in constructing the embankment, the engineers have obtained their material from borrow pits along both sides of the line. It is almost entirely blue clay, with a small amount of sand in certain localities, and though stiff to work, especially in the wet season, makes a substantial surface. On the double track between Shek-wai-tong and Fatshan the formation width on the embankment is 31 feet, with slopes of 1½ to 1. The maximum grade is one-half per cent (1 foot in 200). The maximum curvature is 3 degrees (1,910 feet radius), and on these curves there is a spiral or easement curve. There are only two on this double-track section. At one point considerable trouble was experienced owing to the settlement of the embankment for a distance of about 1,200 feet, and after investigations the engineers decided to cease operations in the borrow pits, and the subsidence is being filled up with sand from the river.

At Fatshan the line is on the same level as Canton. The average height of the embankment is from 3 to 4 feet above the level of the rice fields, rising to a height of about 15 feet at bridges. No large rivers are crossed, only sluggish streams, and at one or two of the bridges the junks will have to unstep their masts in order to pass

COOLIES WHEELING CLAY FROM A BORROW PIT.

beneath. No flooding is anticipated, as the grading is well above extreme high water.

The gauge is the standard one of 4 feet 8½ inches, which will make the line uniform with those of North China, and there is an 8-foot way on the double track. The rails weigh 75 pounds per yard, and are 30 feet long. The track will be ballasted with broken stone to a depth of 16 inches, but the railway will be opened to traffic before this is completed. The sleepers are of steel, about 8 feet long, and weigh about 125 pounds. Like the rails, they come from Belgium. The sleeper is of the rolled form, cut off in lengths, and the ends bent over. The rail is fastened to the sleeper by means of steel clips and bolts. All bolts are provided with spring washers to prevent the nuts from working off.

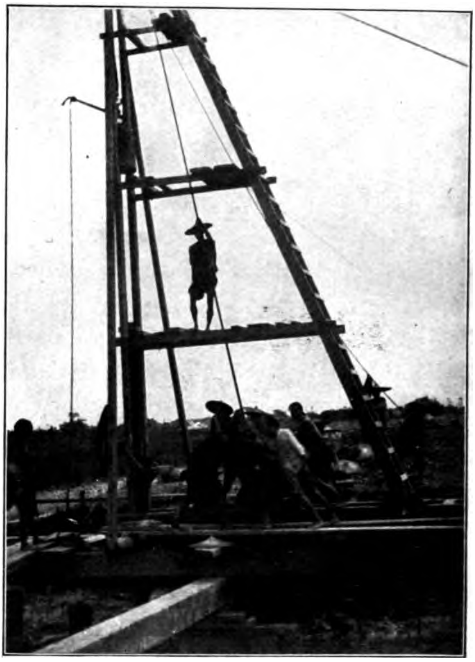
All the rolling stock will come from America. The locomotives will weigh 130 tons. Passenger carriages will provide accommodation for three classes. The freight cars are of 80,000-pounds capacity. There are twenty cars and five light locomotives—the locomotives formerly in use on the New York Overhead—now in the terminal works at Shek-wai-tong. The signalling arrangements have not been completed yet, but it is expected the line will be operated by Americans upon the American system.

All the cement used on the works is supplied by the Green Island Cement Co., Ltd., of Hongkong.

As might have been expected by anyone who knows anything of Chinese guilds, the greatest trouble of the engineers carrying out the work was with the contractors. They failed to fulfil their contracts on time, and in order to get the work finished expeditiously and properly, the company had to take over the whole of the bridging and grading themselves, organising their labour and getting material and implements, such as wheelbarrows, pile-drivers, pumps, etc., for themselves. Since this was done there has been no trouble with the coolie labour. One of the engineers say that it is a fallacy to say that Chinese labour is efficient or cheap, and he sighed for Irish navvy labour, which he maintains would be less costly, more efficient, and would enable the engineers to gauge with a greater degree of certainty the time likely to be occupied on constructional work. Each coolie, man or woman, receives 40 cents per day (11 pence), which is about double the pay of ordinary coolies in China. Sometimes a portion of the gang will strike work, but, on the whole, there is no longer any serious difficulty, and as the company endeavours to get its labour from the villages along the route this has had some effect in producing a pacific attitude.

COOLIES CARRYING SAND FOR AN EMBANKMENT.

When consideration was given to the delays caused by Chinese subcontractors, it must be said that the progress of the work is quite satisfactory. The preliminary survey of the Fatshan section was made in August 1902, and the final survey was completed on January 1 this year. The route of the Fatshan-Samshui section was finally located in April, and ground was broken for that section on September 8. Work was begun on the Canton-Fatshan section in the first week of March, and it will be finished by the middle of November. The Fatshan-Samshui section (which is a single track) will be finished in January next. On that section there are one or two heavy cuttings through clay, but fewer streams to cross and only one large bridge.



PILE DRIVING BY HAND POWER.

I have already mentioned that the lines now in process of construction in South China are being built by the American China Development Company, a purely American company with a capital of $30,000,000 (gold). Mr. Wm. Barclay Parsons is president. The actual work of constructing the main railway and its branches is under the supervision of Mr. Willis E. Gray, general manager, whose head office is at Shanghai. Capt. C. W. Mead is the chief engineer, and Mr. Justin Burns the first assistant engineer. Mr. C. H. Farnham, division engineer, is at the head of the engineering staff on the Canton-Samshui branch line. The foremen of works comprise Americans, Englishmen, Irishmen, Scotchmen, Australians, Frenchmen Germans, Scandinavians, etc., mostly engaged locally or in the Philippines. These men are quartered in large houseboats on the principal streams along the line of railway, and, considering they are engaged on pioneer work, they have, on the whole, a very pleasant time. For the protection of the works generally the company has a uniformed force of 500 native soldiers, armed with rifles and carbines, but no serious disturbance has occurred as yet on this portion of the line.

I am not in a position to discuss the question whether the line will

NATIVE SOLDIERS AND LIEUTENANT.

pay interest upon capital. Personally, I believe railways will be a successful enterprise in China. Progress may be slow in the first few years; but I incline to the view that as railways will have a far-reaching effect upon the national and provincial life of the people, the reaction will be altogether in favour of the pioneer lines, and the effect will be more rapid than most people contemplate. Where the railway competes with water carriage over short distances the Chinese will undoubtedly prefer the passage boat or steam launch. But over long distances, where the railway will carry him safely and quickly, the Chinaman will most certainly choose the railway.

A necessary complement to the Yeun Han Railway is the continuation to Hongkong. In the interests of that colony this line should be undertaken at once, before Canton or Whampoa can become established as the terminus, for if either of these places becomes the chief distributing centre of South China, the commercial value and importance of Hongkong will be seriously endangered. Looking at the question of railways in China in the broadest aspect, however, it must be confessed that the outlook is most encouraging, and the advent of the railway in this vast empire the result will be, as it has been in all other countries, a social improvement in the condition of the masses of the people, coupled with an enormous expansion of national wealth and individual prosperity, and the reformation of a system of government that has grown corrupt with the ages and out of touch with the people and their requirements.

THE WATER POWERS OF BRITISH COLUMBIA.

By E. Jacobs.

It has been pointed out more than once in these pages that natural and economic conditions all assure a most brilliant and almost boundless industrial future for the Pacific Slope of North America. One of the chief elements in that development is the vast power resources of the region. The accompanying brief but vigorous sketch of some of the most important water-power installations north of the Canadian boundary will be followed by a similar study of the larger work in the Pacific States.—The Editors.

THE Dominion of Canada is stated to have a lake area of 77,391,304 acres. Of this large acreage in lakes British Columbia's proportion is at least 2,000,000 acres. In an official bulletin, published by the Government Bureau of Provincial Information early in 1903, a table appears showing the individual areas of sixteen of the larger lakes, ranging from Adams Lake with 33,280 acres up to Atlin Lake with 211,680 acres, and placing their aggregate acreage at 1,560,830 acres. Whilst the water area of the Province is small in comparison with, say, that of Ontario, which has an area of 25,826,306 acres in lakes, it is yet large enough to make it an important feature in the physical characteristics of the Province in their bearing upon its commercial and industrial economy. This is especially the case where the elevation of the lakes and their accessibility are such as to make reasonably practicable the utilisation of their waters for power purposes. It is, though, the rivers and creeks of the Province rather than the lakes that, with one important exception, are being more and more utilised in this direction.

The several extensive mountain ranges of the Province furnish abundant sources of power, not in all cases available the whole year round, yet generally for a sufficiently long season to make it well worth while taking advantage of the power whilst applicable. There are four main ranges; three on the mainland, viz., the Rocky, the Selkirk, and the Coast ranges, and one, known as the Island range, forming the archipelago of islands, great and small, lying to the west of the mainland. These mountains provide immense watersheds, the rains and melting snows passing from them by innumerable watercourses into the rivers and lakes that drain their slopes. The average width

UPPER FALLS, KOOTENAY RIVER, NEAR NELSON, B. C.
As yet undeveloped for power purposes.

of the Rocky Mountains, the central heights of which form the eastern boundary of British Columbia, is about 60 miles, diminishing to the north; that of the Selkirks is about 80 miles, whilst the Coast range has a mean width of about 100 miles. The average height of the Rockies in the Province is given as about 8,000 feet, though several summits occur a little north of the International Boundary line with elevations exceeding 10,000 feet. Higher altitudes are reached where this range appears to culminate in Alberta. The Selkirks enter the Province from the south in a threefold system, known respectively as the Purcell, the Selkirk, and the Gold Mountains. Northwards they are known as the Cariboo Mountains. Their summits rise to 8,000 to 9,000 feet above the sea. The Coast range reaches an average height of about 6,000, with some peaks 7,000 to 8,000 feet high.

The valleys of British Columbia fall into two classes, (1) main or longitudinal valleys, in general having a north-and-south trend, and (2) tributary or transverse valleys, with a prevailing east-and-west direction. The main valleys lie in about the course taken in glacial days by the ice, which chiselled out these long fiord-like valleys as it moved southwards over the country. They are deep and for the most part level, or with only a slight gradient. The transverse valleys lying across the path of the ice were not deepened to the same extent; consequently when the ice disappeared they did not enter the main valleys on grade, but stood above them, often at a considerable height, as hanging valleys. The streams are still cutting these down to the level of the main valleys, by wearing back canyons having waterfalls at their heads. As a consequence most of the water powers are on the east-and-west valleys, many of these tributary valleys possessing waterfalls suitable for water-power purposes, these varying with the size of the stream. This frequent occurrence of available power, usually within easy reach and conveniently situated for industrial purposes, has already been taken advantage of in many instances in the Kootenay mining districts, where numerous concentrators, stamp mills, electric-light plants, etc., are in operation, the considerable pressure head obtainable from a comparatively small stream in a short distance making effective installations practicable at moderate cost. In a general way it may be stated that these tributary valleys furnish power, whilst the longitudinal valleys afford facilities for transportation.

The unique position of British Columbia as a watershed on the west coast of America will at once be recognised when it is seen that the rivers of great importance on that coast, with the exception of the Colorado and the Yukon, take their rise within its boundaries. The drainage from its extensive area of mountains and highlands is received into the numerous lakes already noticed. Thence the surplus is discharged into the few large rivers, or their many tributaries, which finally reach the sea. These rivers are the Columbia on the south (debouching through United States territory into the Pacific Ocean); the Fraser (750 miles long), the Skeena (300 miles), and the Stikine, on the west; the Liard (more than 300 miles in British Columbia) on the north, and the Peace (also more than 300 miles in British Columbia) on the east. These rivers are of great size and volume, and the first-named four are sufficiently navigable to steamers to form waterways of no small value in the development of the country.

So far as known to me no official or other competent survey or report has been made of the water power available in British Columbia. This summary of the water-power resources of the Province must, therefore, of necessity be very incomplete. In the absence of the data requisite for making an estimate of the total available hydraulic power, all that will be undertaken will be to direct attention to the more

SITE OF THE CONCRETE DAM, VANCOUVER POWER COMPANY'S POWER PLANT.

prominent instances in which some of this abundant power is already in use, or to preparations being made to utilise it. Perhaps the more interesting are undertakings where the hydraulic development of electrical power involves the installation of electrical and transmission plant, but before turning to these, several representative cases of the direct application of hydraulic power, including one of hydraulic placer mining, will have notice.

The official statistics of the Provincial Department of Mines show that during forty-five years—1858 to 1902—the production of placer gold in British Columbia totalled in value $64,627,683. The annual yield ranged from a maximum of $3,913,563 in 1863 to a minimum of $356,131 in 1893, and the average yearly yield over the whole period was $1,436,171. During recent years hydraulic mining has contributed materially to the production of placer gold. This industry has received most attention in the Cariboo and Cassiar Districts, both in the northern part of British Columbia. During several years last past, however, the rainfall in these districts was considerably less than in earlier years and consequently hydraulic operations were proportionately restricted, but this state of affairs is not expected to continue indefinitely; in fact, the present outlook promises a change for the better next season. Whilst in the past the greater portion of the placer gold yield came from the richer and shallower gravels—$25,000,000 to $30,000,000 are credited as the production of 2½ miles of Williams Creek and 2 miles of Lightning Creek, both streams in the Cariboo District—it is from the immense auriferous deposits contained in the older and deeper channels, which must be worked by hydraulic methods, that large returns may be expected in the future. Of the numerous hydraulic placer-mining enterprises of British Columbia the most important is that of the Consolidated Cariboo Hydraulic Mining Co., Ltd. From a report made in 1900 by the manager, Mr. J. B. Hobson, the following is taken:

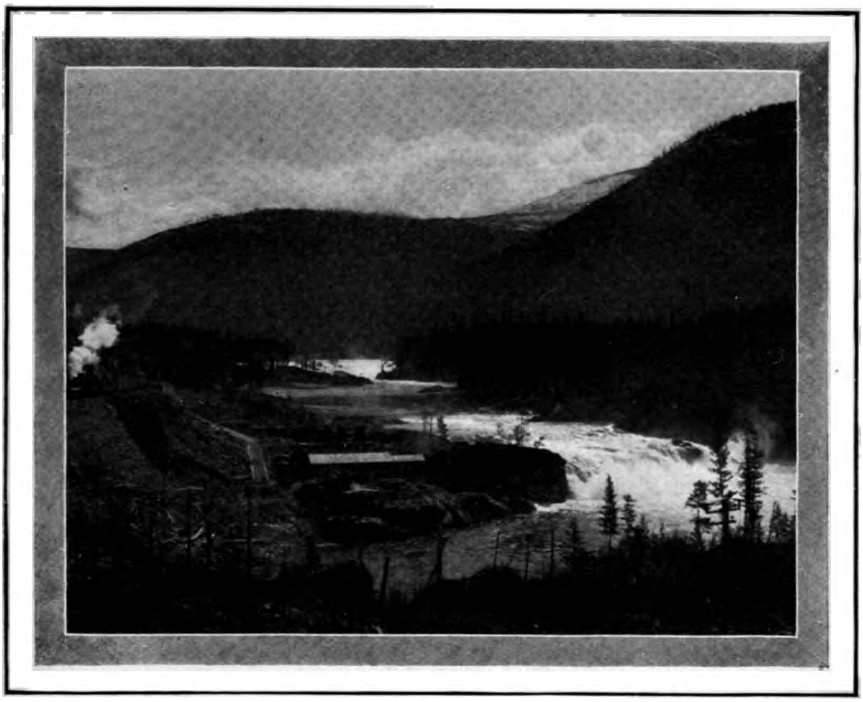
> "The company's property is located in the Quesnel River mining region, famous for its rich shallow placers, its extensive system of ancient river channels, and its immense deposits of auriferous gravels. It is situated at Bullion, Cariboo District, about 190 miles by waggon from Ashcroft, on the main line of the Canadian Pacific Railway. The property comprises 34 placer-mining leases, aggregating 2,584 acres of land. These mining leases cover, for a distance of about 10 miles, the auriferous deposits of a system of ancient rivers. The deposits included in the company's property vary from 400 to 600 feet in depth from surface to bottom of channel. The quantity is estimated at 500,000,000 cubic yards of auriferous gravel that is available for future washing by hydraulic process. The company's water-supply system, as now completed, consists of 33 miles of well-constructed canals, having a capacity for delivering at the mine 5,000 miner's inches of water under a head of 420 feet. The sources of supply are at three lakes 10 to 19 miles distant, these having an aggregate capacity for storing 1,016,000,000 cubic feet of water, which is equal to 470,370 miner's inches of water. This storage supply is greatly augmented by the waters of streams tributary to the main canals between the storage reservoirs and the mine."

The mine equipment, which is an extensive one, includes a portable hydraulic plant of four lines of 30-inch and 22-inch rivetted steel pipes, aggregating 6,000 feet, and six No. 8 hydraulic giants, with deflecting nozzles, varying from 6 to 10 inches in diameter. The gold-saving appliances consist of a double-extended system of sluices 7 feet wide by 4 feet deep, aggregating 2,380 feet in length; also two improved undercurrents of longitudinal steel riffles, for the recovery of flour quicksilver, fine gold, platinum, and osmiridium that cannot be recovered in the ordinary sluices.

As illustrative of the difficulties that follow an insufficient rainfall it may be mentioned that instead of being able to hydraulic the full mining season of six to seven months, this company had in 1901 only enough water for 104 days' run, and in 1902 for 66 days' run. In the former year 2,420,288 cubic yards of gravel were moved, this yielding $142,275, and in the latter 690,442 cubic yards producing $61,395.

As examples of numerous concentrating plants in the Slocan District mention may be made of the Whitewater silver-lead mine, where five 24-inch Pelton wheels, driven under a 450-foot head of water brought in only 2,500 feet, operate a 200-ton concentrator; and of the Enterprise mine, where Peltons under 110-feet pressure head of water brought 3,000 feet, drive a 75-ton concentrating mill together with a direct-connected air compressor. At the Ymir gold mine, in the Nelson District, an 80-stamp mill, with vanners, etc., of a daily capacity of 200 tons, is operated by Pelton and Tuthill wheels driven under a 430-foot head with a 4,500-foot flume. In the same mining district a water-driven 20-stamp mill at the Poorman mine crushes 40 to 45 tons of gold quartz daily, whilst at Ainsworth the Highland mine 150-ton concentrator, also operated by water power, works right along on silver-lead ore. During a recent trip into the Lardeau District I saw nearing completion at Camborne, on Fish River, two 10-stamp mills for treating gold quartz from the Eva and Oyster-Criterion mines, respectively, power being obtained from a neighbouring creek. In the same district the Union Iron Works, of San Francisco, Cal., is erecting near Ferguson for the Silver Cup Mines, Ltd., a 20-stamp combination silver mill to be run by electricity generated by power taken from the South Fork of Lardeau Creek, a pressure of 140 feet being obtained with a flume about 4,000 feet in length. Again, the Stave Lake power, in the Lower Fraser District, has lately been taken over by American capitalists, whilst on the coast, Clowhom River Falls, at Sechelt Inlet, have been secured by one company, and Powell River Falls, near Malaspina Straits, by another, both companies being interested in the establishment there of the pulp and paper industry. Scores of other instances might be cited, but these will serve to show that the water powers are being utilised to an increasing extent.

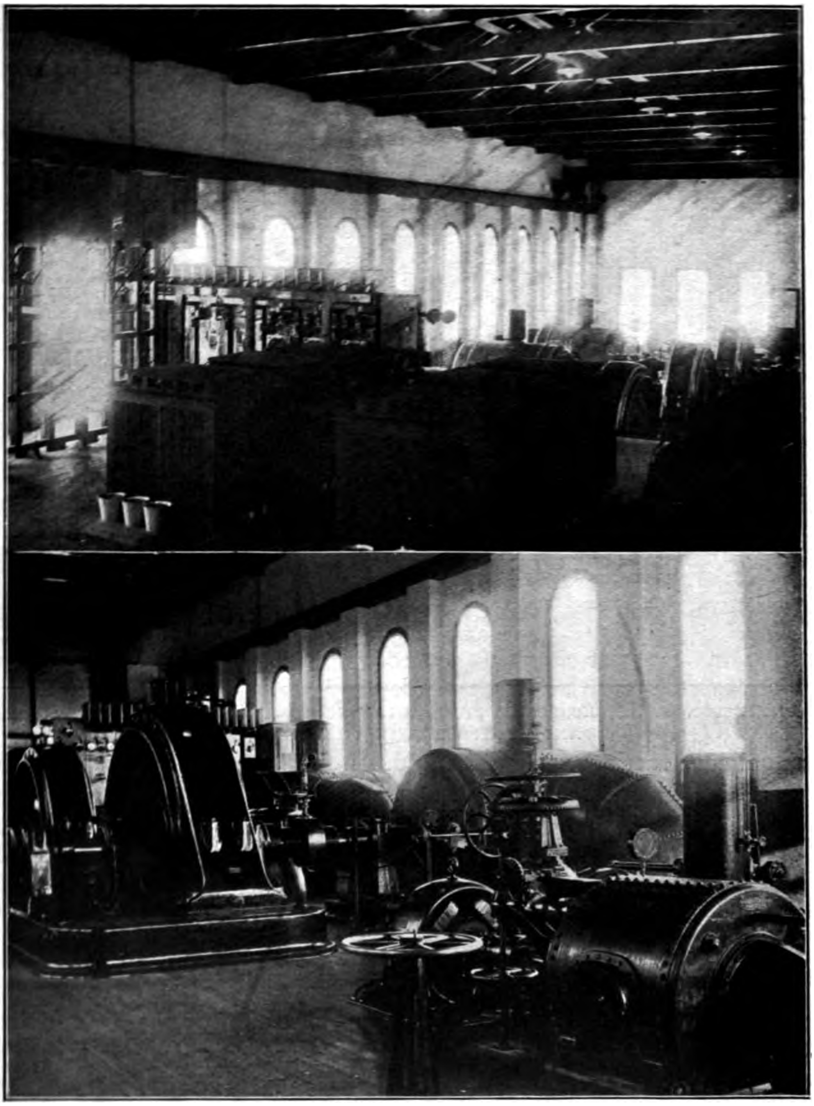
The most important hydraulic development of electrical power in the Province is that of the West Kootenay Power & Light Co., which for about five years has been developing power at Bonnington Falls, on the Kootenay River, about eleven miles west of the town of Nelson. The conception and commencement of this enterprise were largely due to Sir Chas. Ross, Bart., of Balnagown, Scotland, and Mr. Oliver Durant, the manager at Rossland for the Centre Star Mining Co., whilst to Mr. Lorne A. Campbell was entrusted the installation of the plant and the further execution of the plans of the company. Preliminary surveys were made early in 1897, and in July of that year



BONNINGTON FALLS, KOOTENAY RIVER, SHOWING POWER STATION IN FOREGROUND AND UPPER FALLS IN THE DISTANCE.

actual construction was commenced. Before the close of 1898 power was being supplied to mines at Rossland. The plant was built essentially for power purposes. Of its load only a comparatively small percentage is used in lighting, by far the greater part being in synchronous and induction motors for the operation of machinery at mines, smelters, manufactories, etc., and for a street-car service at Nelson.

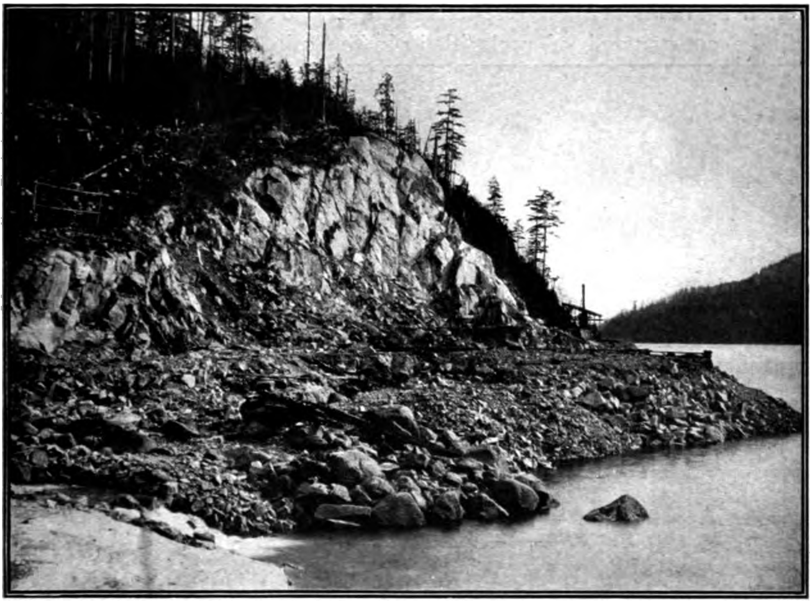
It is estimated that Bonnington Falls, both upper and lower, have a capacity at low water of 267,000 horse power. The West Kootenay Co., however, is thus far utilising only a portion of the lower falls, which, under the 40-foot head available, are capable of delivering 100,000 horse power. A large reef of rock crosses the river, here about 400 feet wide. The power plant is located under the higher portion of this reef, the river falling over the lower part of it. A canal cut 650 feet through the rock opens out into a forebay 54 feet wide and closed in by a solid concrete dam. Three feeders open into steel penstocks run through the dam and into the hydraulic section of the power house below. These connect with three 39-inch Victor turbines. In the generator room are three 40-kilowatt 125-volt multi-



POWER PLANT OF THE CASCADE WATER POWER & LIGHT COMPANY.
The lower view shows the 750-kilowatt alternating-current generators; the upper shows the 250-kilowatt self-cooling transformers in the other end of the power house. The electric installation is by the Westinghouse Electric & Manufacturing Co.

polar exciters, and three generators—two 750-kilowatt units and one 1,500—of the Canadian General Electric Co.'s standard revolving-field type. From the generators the mains are led off underground to a 10-panel switchboard, and thence to the raising transformers, of which there are twelve, each having a capacity of 250 kilowatts. An air blast is supplied to these by three 60-inch Buffalo blowers, each operated by a 2-horse-power 100-volt induction motor. The current is delivered to the transmission lines at pressure of 20,100 volts.

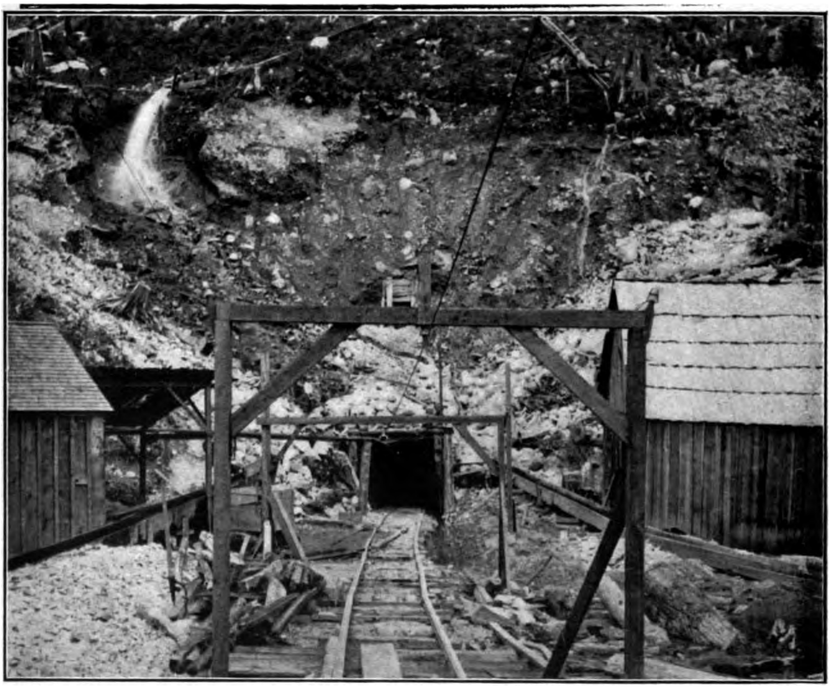
The power house is a brick building, with galvanised iron roof. It is divided into three compartments—a turbine room 25 feet by 64 feet, a generator room 31 feet 6 inches by 66 feet, and a transformer room 17 feet 6 inches by 28 feet. The transmission lines westward to Rossland 32 miles, with a 4-mile branch to Trail, and in the opposite direction to Nelson, are built over a rough heavily-wooded country. The variation in altitude at different points is more than 2,200 feet. There are two separate pole lines, each carrying three No. 2 B. & S. copper wires. The fireproof sub-stations at Rossland, Trail, and Nelson, are provided with transformers, switchboards, and all other apparatus necessary for the reduction of the current to a pressure suitable for use in mines, smelters, etc., and for lighting purposes in the towns.



POWER HOUSE EXCAVATION, VANCOUVER POWER COMPANY.
Engineering Offices, San Francisco, engineers; Wynn Meredith, consulting engineer in charge.

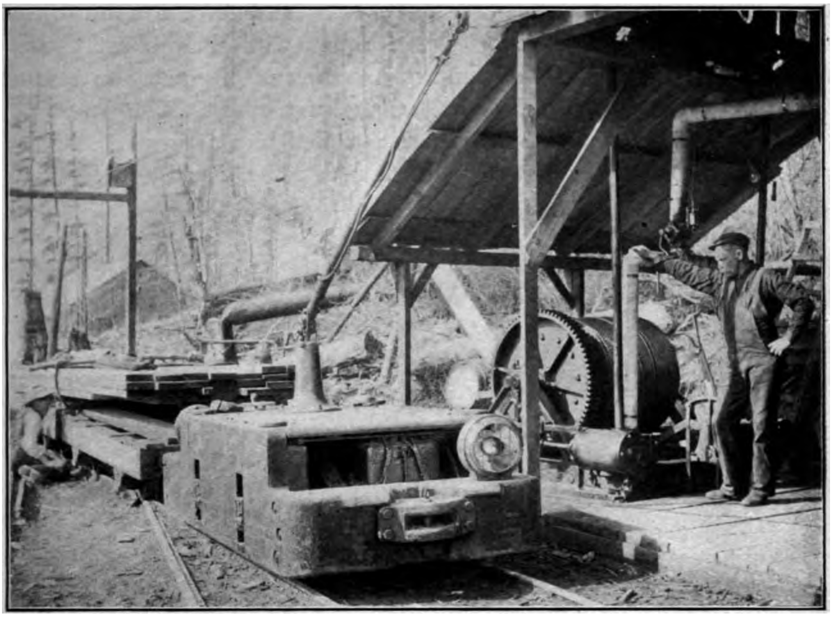
The Vancouver Power Co. is installing a hydro-electric transmission plant designed to be capable ultimately of delivering 30,000 horse power to the cities of Vancouver and New Westminster and the neighbouring district. The initial installation will be equal to the generation of 9,000 horse power, which will be used for operating the interurban railway system of those cities, and for electric lighting. The undertaking was commenced in the early summer of 1902, and it is expected that it will be possible to generate power for immediate requirements by the end of 1903, but the completion of the works will yet be a matter of at least a year.

The sources of water supply are Coquitlam and Trout Lakes, both deep glacial lakes. Lake Coquitlam has an area of 2,300 acres, and it is at an elevation of 32 feet higher than Trout Lake, which is 460 acres in extent. Rugged mountains, rising abruptly from the shore lines, surround both lakes to their outlets. Between them a granite range rises 4,000 feet above water level, and it is through this range that a 9 feet by 9 feet tunnel, 13,000 feet or nearly two and one-half miles in length, is being driven to connect the lakes to admit of the stored waters of Coquitlam Lake being used for the main supply, Trout Lake being the balancing reservoir. The lakes will be controlled by dams at their respective outlets. That on Coquitlam Lake will be constructed of rock-filled timber crib, and it will raise the



TUNNEL PORTAL, TROUT LAKE, VANCOUVER POWER CO.'S INSTALLATION.

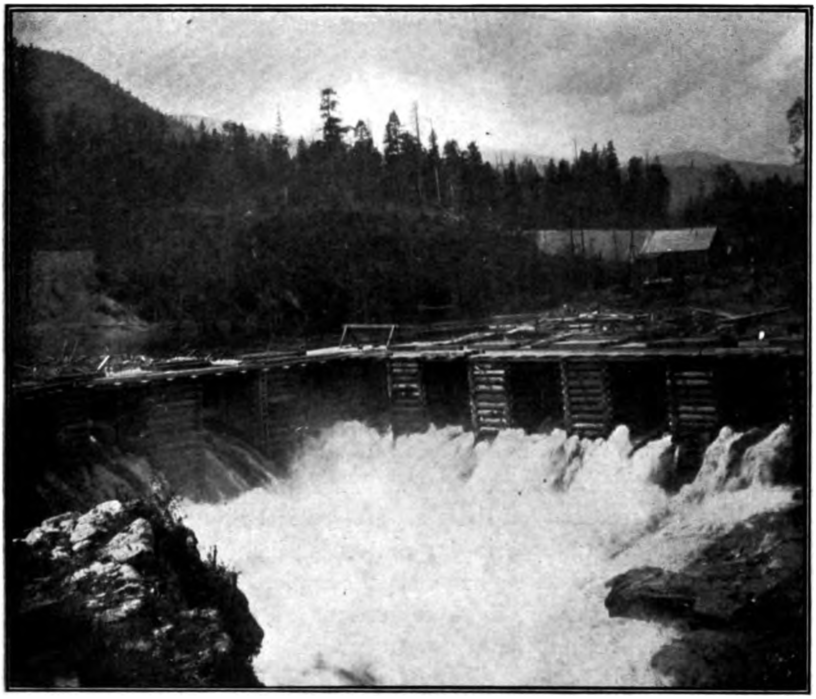
80 feet of overlying debris being sluiced out.



INCLINED TRAMWAY HAULING ENGINE AND ELECTRIC LOCOMOTIVE FOR TUNNEL HAULING, VANCOUVER POWER COMPANY'S CONSTRUCTION WORK.

water 12 feet above low-water level. That on Trout Lake is of concrete; it is 350 feet long on the crest and 50 feet high. Provision has been made for eventually bringing out ten 54-inch steel pipe lines, but for the present only three have been completed. These run 1,600 feet to the power station, in three sections of 48, 44, and 42 inches respectively, delivering the water under an effective pressure head of 390 feet.

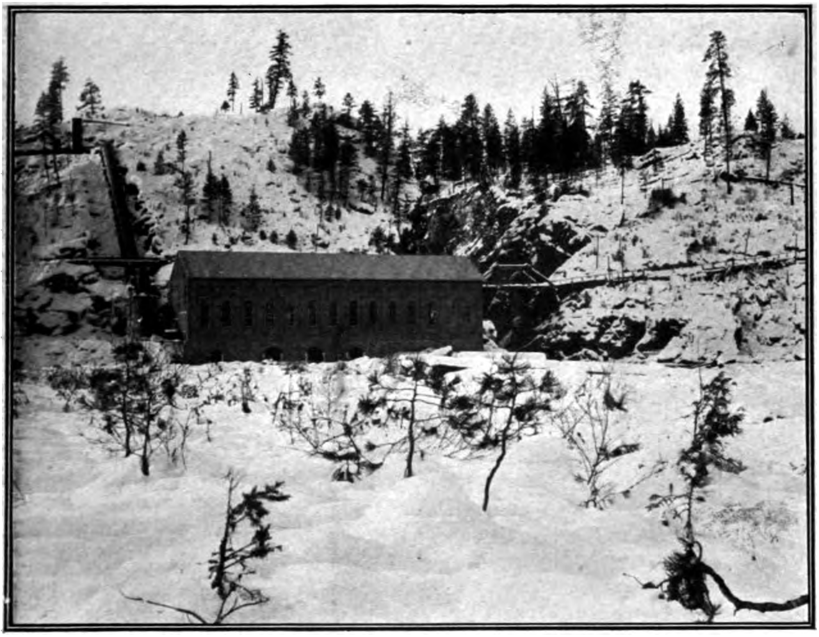
The power house is substantially built, of granite masonry. The water-wheel equipment consists of three sets of Pelton impulse wheels, each capable of developing a maximum of 3,000 horse power, and one set of 200-horse-power wheels, all enclosed in cast-iron housings. Each of the main units has two overhung wheels, one mounted on each end of the shaft of a 1,500-kilowatt, 60-cycle, 2,200-volt, Westinghouse engine-type rotating-field generator. An interesting feature here is the combination of needle valve and deflecting nozzle in the regulation of the water wheels, this permitting of load and speed variations independent of any change of velocity in the pipe lines. The two 80-kilowatt exciters, with their respective wheels, are mounted on a common bed plate, with a 120-horse-power motor between them. The switchboard has nine panels—one for the induction motor and one for each exciter, three for controlling the main units, and three for the three sets of 550-kilowatt air-cooled transformers with their blower sets, these last consisting of 20-horse-power motors and 110-inch Sturtevant fans. The step-up transformers, static interrupters, high-potential switches, and lightning arresters, are installed in a separate building placed above and behind the power house. The machinery for the sub-stations at Vancouver and Burnaby includes the usual transformers, rotary converters, switchboards, etc., for the reception and distribution of transmitted power.



CASCADE WATER POWER & LIGHT COMPANY'S DAM, ON THE KETTLE RIVER, CASCADE CITY, BOUNDARY DISTRICT.

Two independent transmission lines, each consisting of two 3-wire circuits, of No. 2 copper wire, crossing Burrard Inlet with a span of 2,800 feet, run to Barnett, whence one connects with Vancouver at 16 miles from the power station and the other with the old power station at Burnaby. The existing transmission line between Burnaby and Vancouver will be reconstructed to carry 20,000 volts, the pressure to be used on the new lines, and a new line will be built from Burnaby to New Westminster. In effect a double transmission line will be provided over the entire distance between the power station and each of the sub-stations.

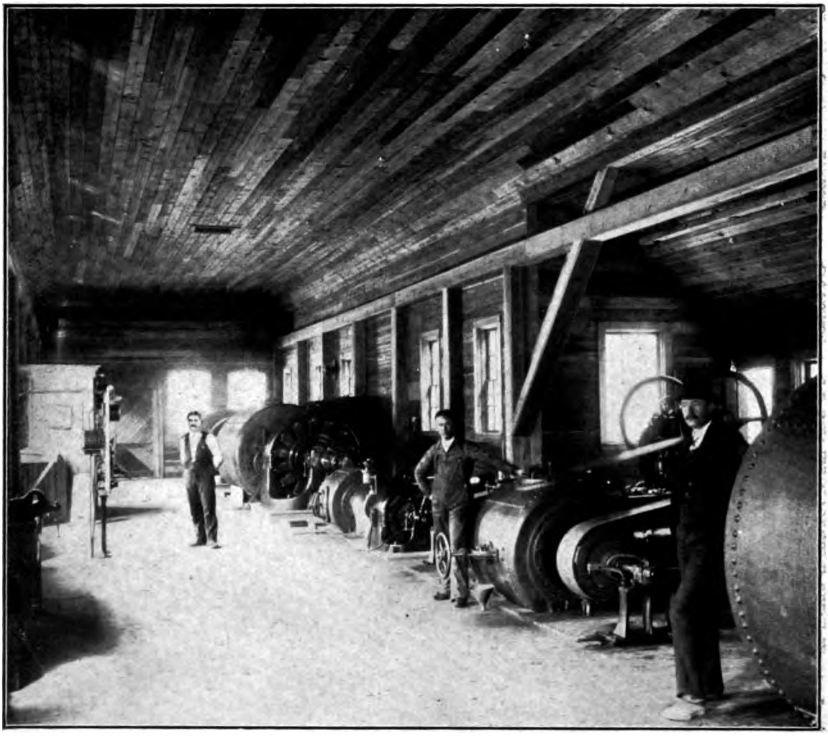
At Cascade City, in the Boundary District, the Cascade Water Power & Light Company has constructed a dam across Kettle River, where there is a water power estimated at between 6,000 and 7,000 horse power at low water. The dam is 400 feet long, and at its deepest part is 50 feet high, raising the water sufficiently to give a head of 150 feet when delivered at the power house erected below the Cascade Falls and distant about 2,500 feet. The water is conveyed in a channel cut in the rock for about 1,100 feet and then through a circular stave-pipe line, 7 feet in diameter and 1,400 feet in length, passing thence through a steel pressure pipe to three direct-connected McCormick turbines each running one Westinghouse 750-kilowatt 3-phase generator wound for 2,200 volts. Two 12-inch turbines operate two 45- kilowatt exciters. Nine transformers raise the current to 20,000 volts, at which pressure it is transmitted over a high-tension circuit of two separate 3-phase transmission lines built from Cascade via Grand Forks and Phoenix to Greenwood, about 26 miles. Sub-stations reduce and distribute the power, at Grand Forks to the Granby Co.'s 2,000-ton smelting works; at Phoenix to the same company's big copper mines, where



GENERAL VIEW OF POWER HOUSE, CASCADE WATER POWER & LIGHT COMPANY.

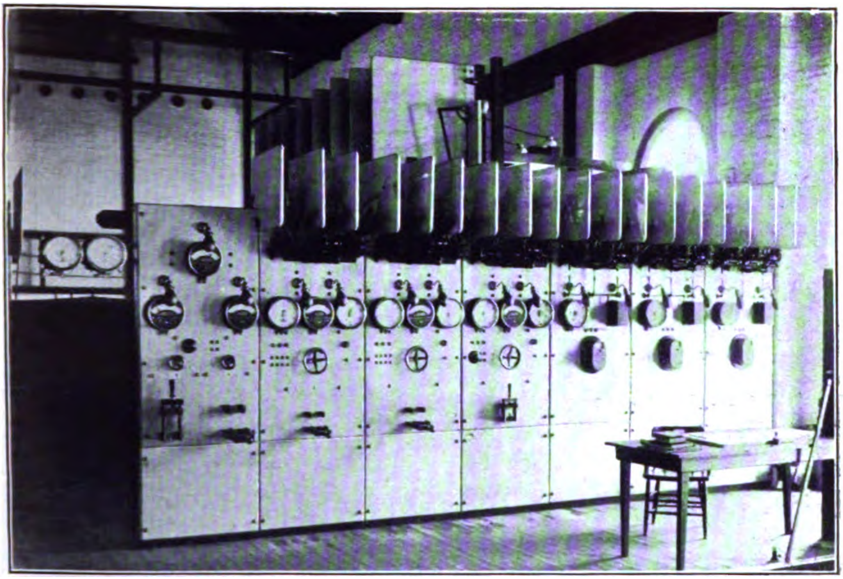
a 60-drill air compressor is operated by two 700-horse-power induction motors, and a large rock crusher by a 100-horse-power motor, and to the Snowshoe mine to run a 150-horse-power electric hoist; and at Greenwood to the B. C. Copper Co.'s smelting works. Grand Forks, Phoenix and Greenwood are all lighted by electricity. The Cascade Co. generates about 2,000 horse power, with one unit in reserve.

Besides utilising power obtained from the Cascade Co., the Granby Co. has its own power house near its smelting works, on the North Fork of Kettle River. The water is brought from a dam, situate about a mile up the North Fork, in a 9 by 12-foot wood flume, and it gives a pressure head of 45 feet. The power plant includes four sets of Dayton Globe Works 16-inch turbines, each directly connected to a Westinghouse rotating-armature, alternating-current generator, these together developing 1,100 horse power. Other turbines are belted to Stilwell-Bierce & Smith-Vaile triplex pumps, which pump water for granulating the slag and for the water jackets of the blast furnaces, and for supplying water to the town of Grand Forks.

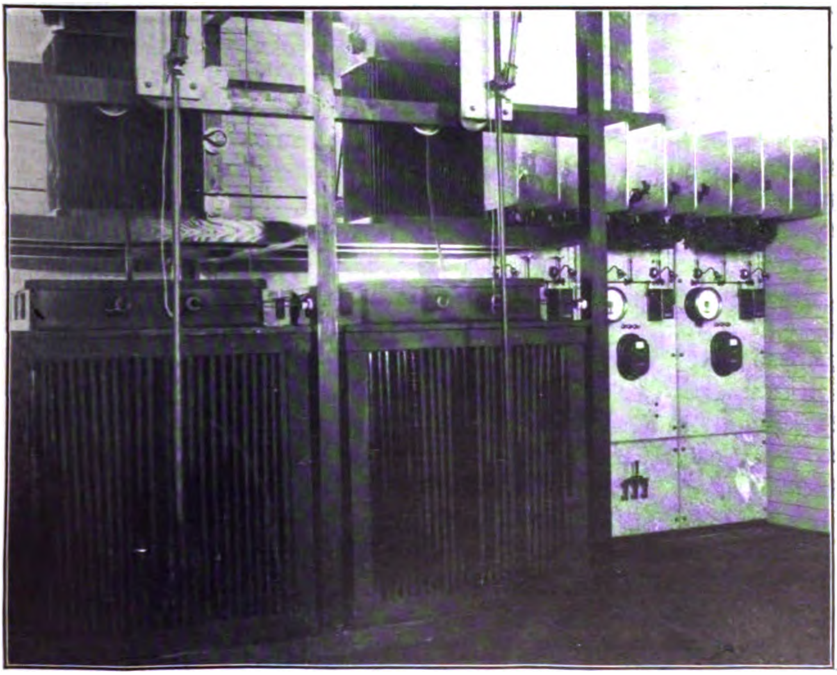


TURBINE INSTALLATION, GRANBY MINES, KETTLE RIVER WATER POWER.

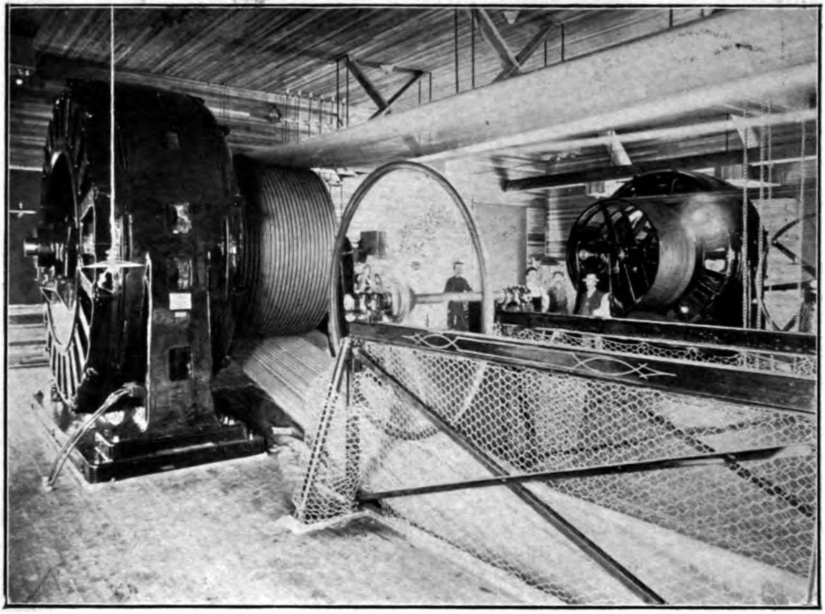
Three pairs 16-inch turbines, one 13-inch and one 10-inch single. Dayton Globe Iron Works.



SEVEN-PANEL SWITCHBOARD, CASCADE WATER POWER & LIGHT COMPANY'S POWER HOUSE, CASCADE, B. C.
Westinghouse Electric & Manufacturing Co.



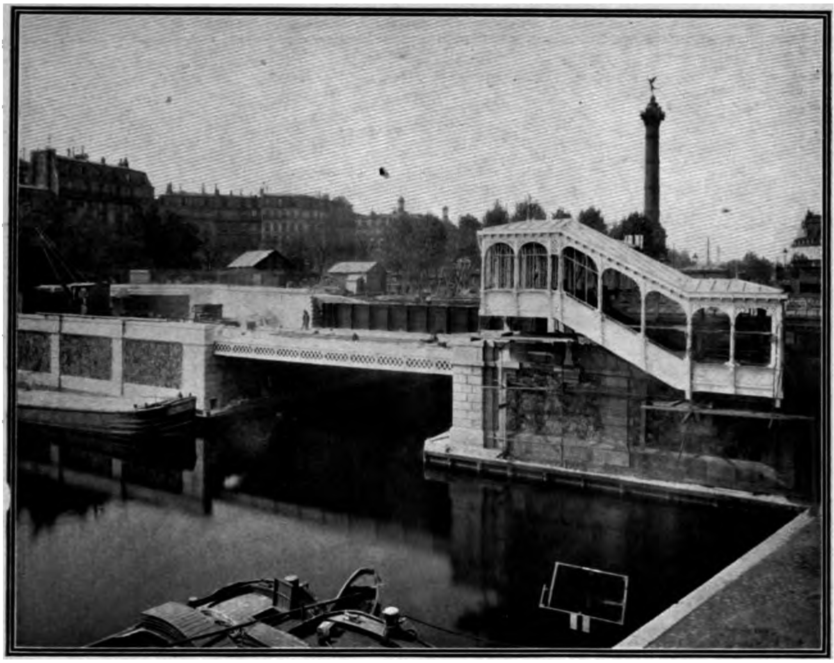
INTERIOR OF SUB-STATION, CASCADE WATER POWER & LIGHT CO. PHOENIX.
Westinghouse Electric & Manufacturing Co.'s machinery.



TWO 700-HORSE-POWER INDUCTION MOTORS DRIVING TWO 30-DRILL AIR COMPRESSORS, GRANBY COMPANY'S MINES, PHOENIX, BOUNDARY DISTRICT, B. C.

Power supplied by the Cascade Company.

The plants mentioned are important, but it is evident that the development of the available power is only in its infancy, and that as the immense mining and lumbering resources of the Province become generally turned to profitable account there will open up a widening field for the skill of engineers and the products of engineering manufactories, of considerable importance. With such enormous latent power as that of the Fraser River, from where it is joined by the Thompson River at Lytton for about 50 miles down to Yale, the head of river navigation, the fall between these two points being nearly 500 feet; that of the Columbia River, also as yet practically unused for power purposes; that of the Kootenay River, from Kootenay Lake (with its estimated area of 141,120 acres) along its 40 to 50-mile course to where it joins the Columbia, and having a series of rapids and falls below Nelson; that of the plunging Elk River, within a short distance of the big coal mines of the Crow's Nest Pass country, besides the available waters of many smaller streams—with such great advantages in association with the possession of illimitable resources in its mines, its forests, and its fisheries, the industrial and commercial future of British Columbia certainly appears to be big with promise.



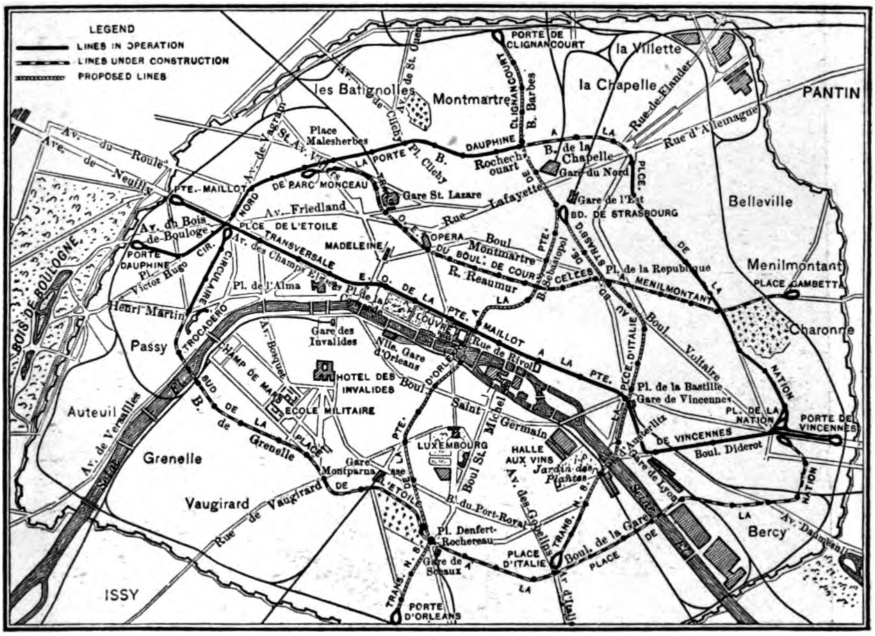
PLACE DE LA BASTILLE STATION, METROPOLITAN RAILWAY OF PARIS.

THE METROPOLITAN RAILWAY OF PARIS.

By Paul Letheule.

Mons. Letheule's article, with its very fine illustrations, is particularly noteworthy just at this time on account of the activity of interest in city transportation. New York and London are facing problems of which every growing city will sooner or later meet a counterpart. Every lesson drawn from actual experience is of value.—The Editors.

THE construction of the Metropolitan Railway System reflects the highest credit upon the engineers and contractors entrusted by the city of Paris with the execution of this important undertaking. The technical staff of city engineers identified with these remarkable works consists of Mr. Bienvenue, chief engineer, assisted by Messrs. Biette, Locherer and Briotet, assistant engineers; Mr. Pollet, chief inspector; Mr. Thomas, and Mr. Hervieu, chief clerk of the board. At first, contractors viewed the undertaking with such utter indifference that the city, being unable to obtain bids on the work, had to build and complete the first section itself. After that, however, interest was aroused, competitive bids tendered, and contracts awarded for the balance of the work at a considerable saving to the city over original estimates of cost.



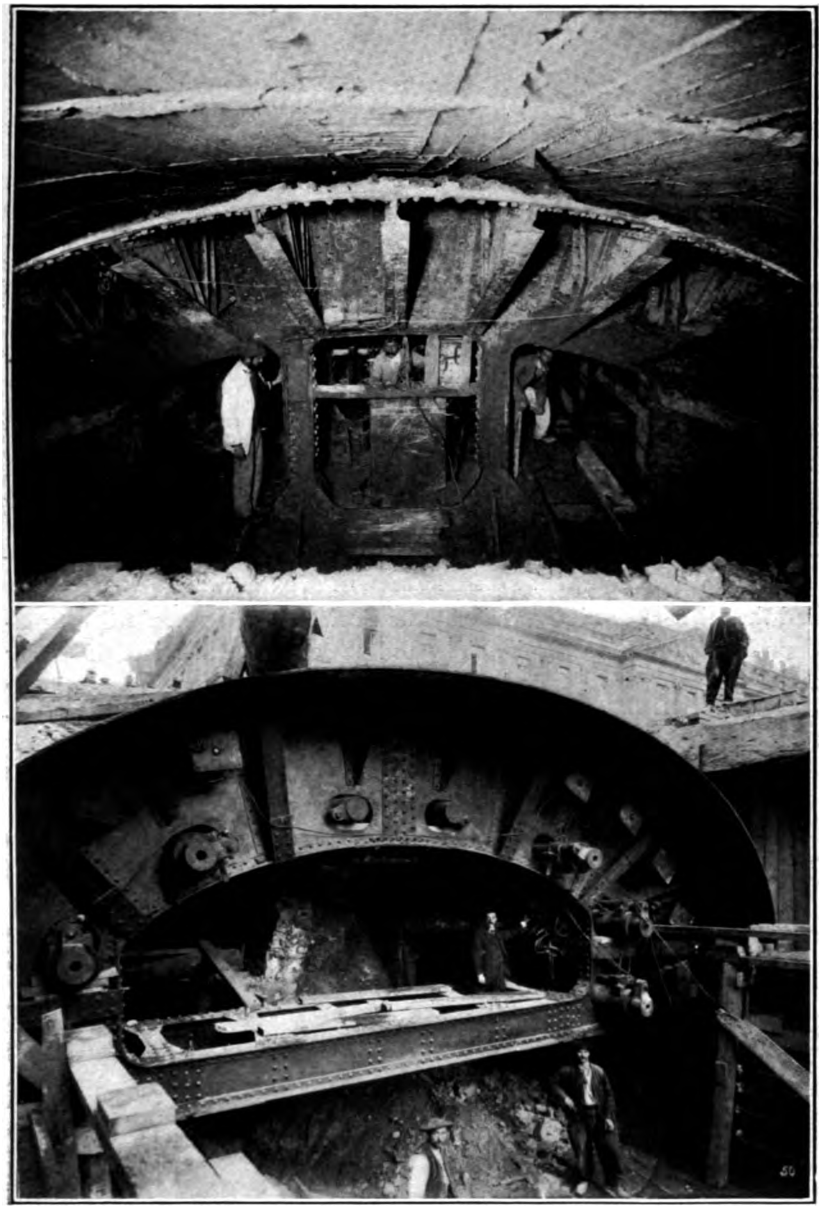
THE COMPLETED AND THE PRINCIPAL PROJECTED LINES, METROPOLITAN RAILWAY, PARIS.

The necessarily concise form of this article makes it impossible to describe in detail the engineering features of the work, which are best shown by the accompanying cuts illustrating the methods adopted in the construction of lines 1, 2, 3 and 4. The map shows the completed lines, those under construction, and the chief of the proposed additions.

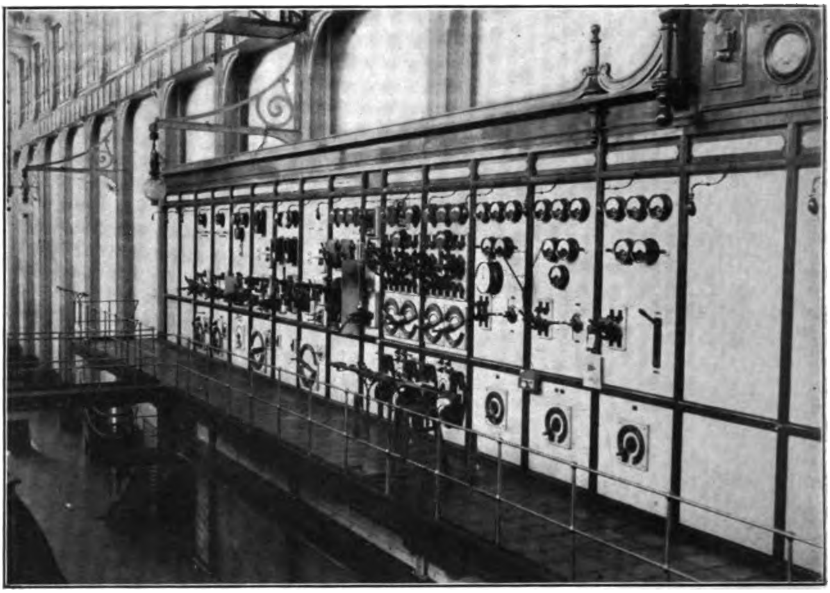
The purpose of this article will be to describe the power plants generating the alternating current, the high-tension transmission lines, the sub-stations, and the direct-current wiring system.

The railway and lighting service in the tunnel is operated by a 550 to 600-volt direct current, transformed at stated intervals from a three-phase 6,000-volt 25-cycle alternating current.

Instead of having one single central power station for the entire system, three separate plants have been in use ever since the system was put in operation, as before the completion of the power house at the Quai de la Rapée, at Bercy, belonging to the Metropolitan Railway Company, there were already two other plants in operation furnishing light and power in the metropolitan district of Paris, the one at Moulineaux, built by the French Westinghouse Company, to supply power to the Western Railway Company (Chemins de fer de L'Ouest),

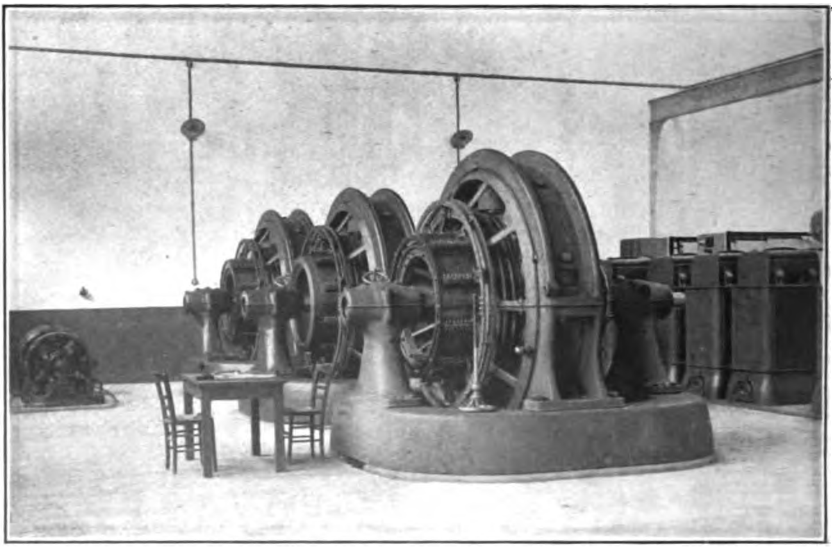


THE UPPER VIEW SHOWS THE FRONT OF THE SHIELD USED IN REGULAR TUNNEL WORK; THE LOWER, THE BACK OF THE SHIELD.

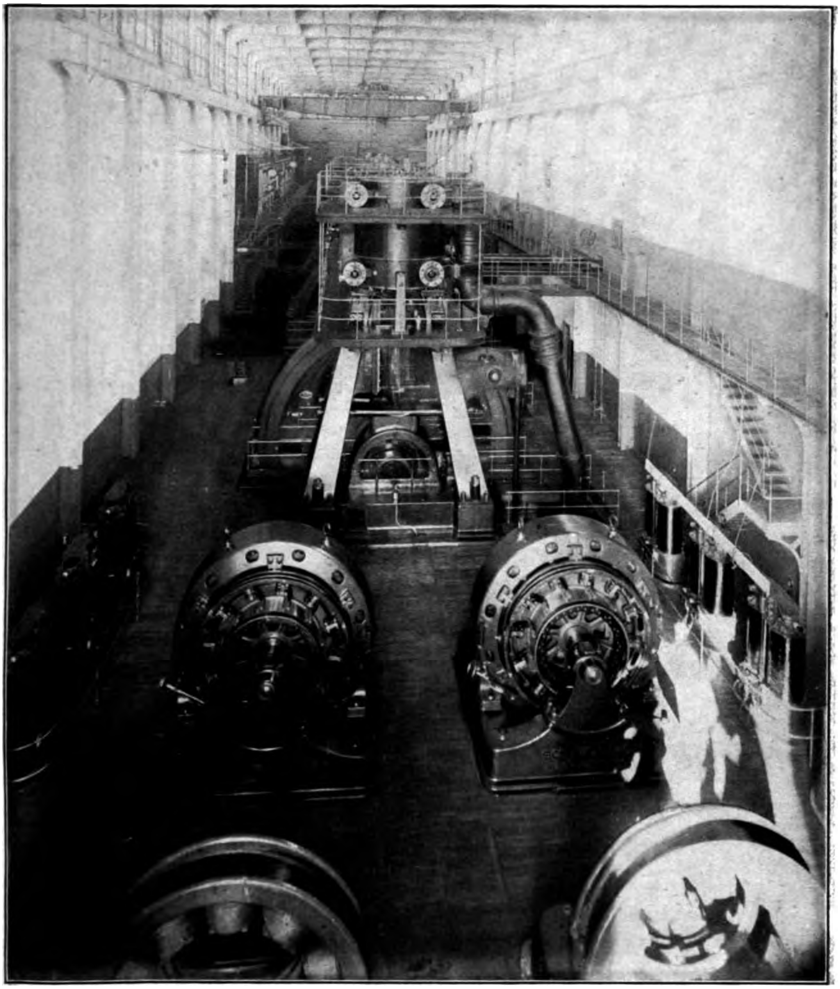


BERCY STATION SWITCHBOARD; THE DYNAMO PANELS.

and the other at Asnières, built by the Société Alsacienne de Constructions Mécaniques, to furnish light and power in the districts of Clichy and Asnières. The third plant belonging to the Metropolitan Railway



GENERAL VIEW OF BARBES SUB-STATION.

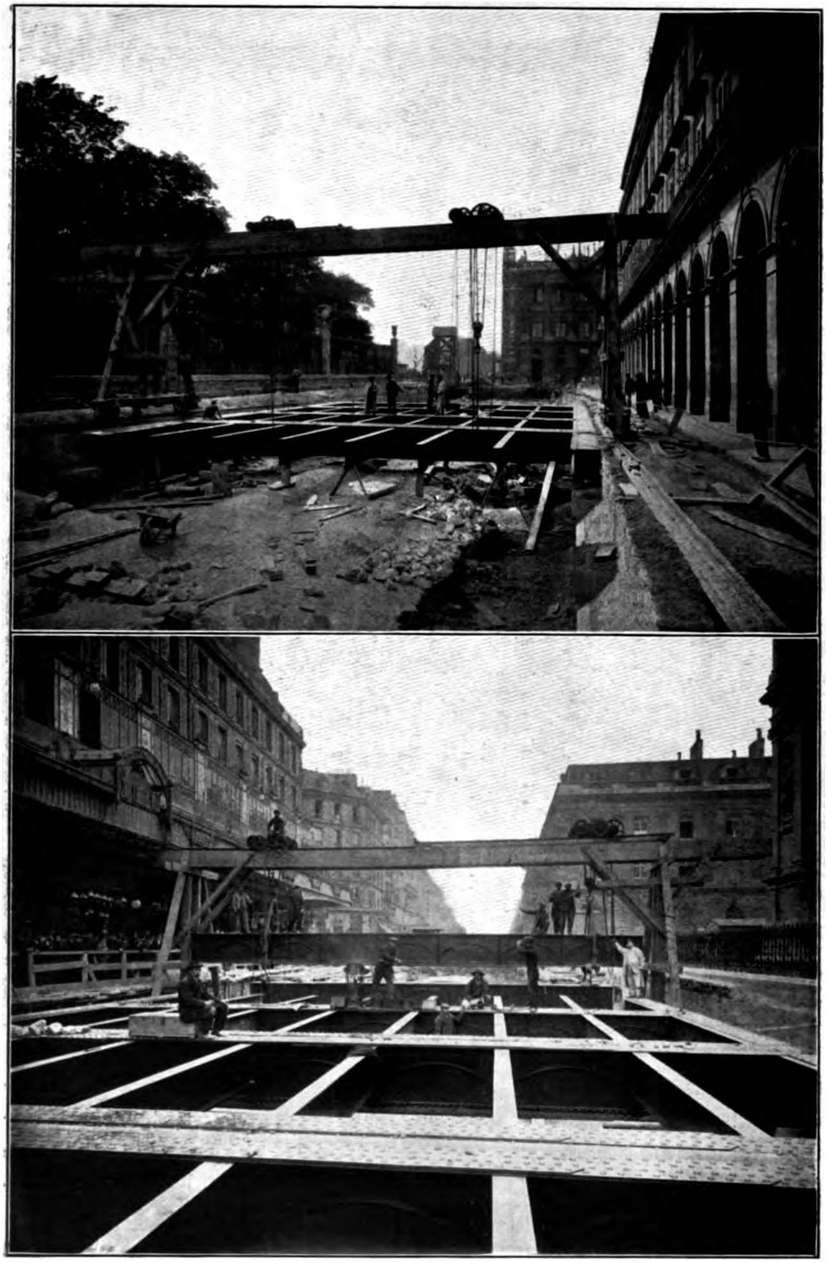


THE BERCY GENERATING STATION.

Company is situated at 45 Quai de la Rapée, at Bercy, near the Gare de Lyon Station, and very close to the first line, which it is therefore able to operate economically by direct current. This power house generates both alternating and continuous current, and at present contains the following equipments:—

One 1,500-kilowatt direct current set,
Three 1,500-kilowatt alternators,
Two 750-kilowatt rotary converters and their transformers.

Extensions are being built to make room for these additions:—



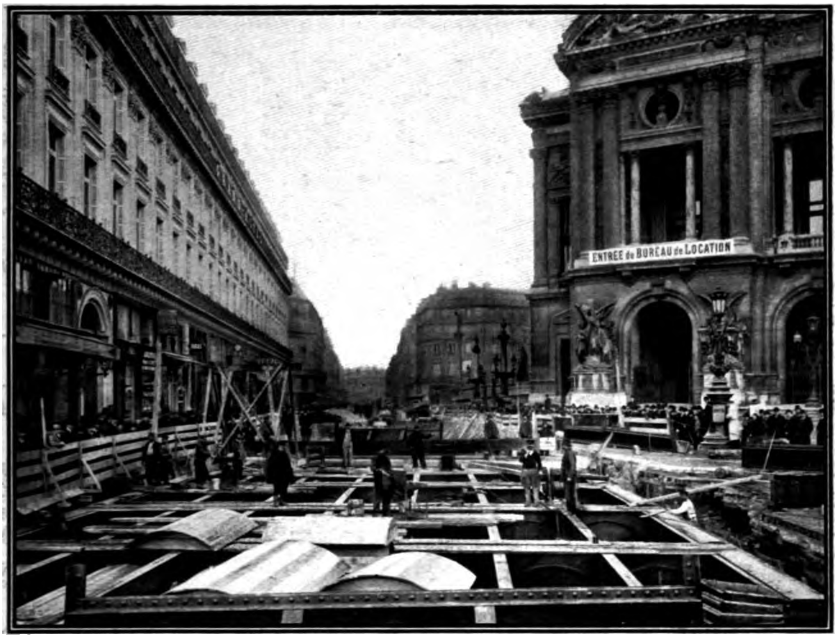
VIEWS ILLUSTRATING FIRST AND SECOND STAGES OF THE CUT-AND-COVER WORK.

The upper picture shows the steelwork of the roof in position, before the excavation. The lower shows the completed excavation for a station, with the steel framing of the roof in place.

Two 2,000-kilowatt alternating-current generators, with the necessary engines, boilers, etc.,

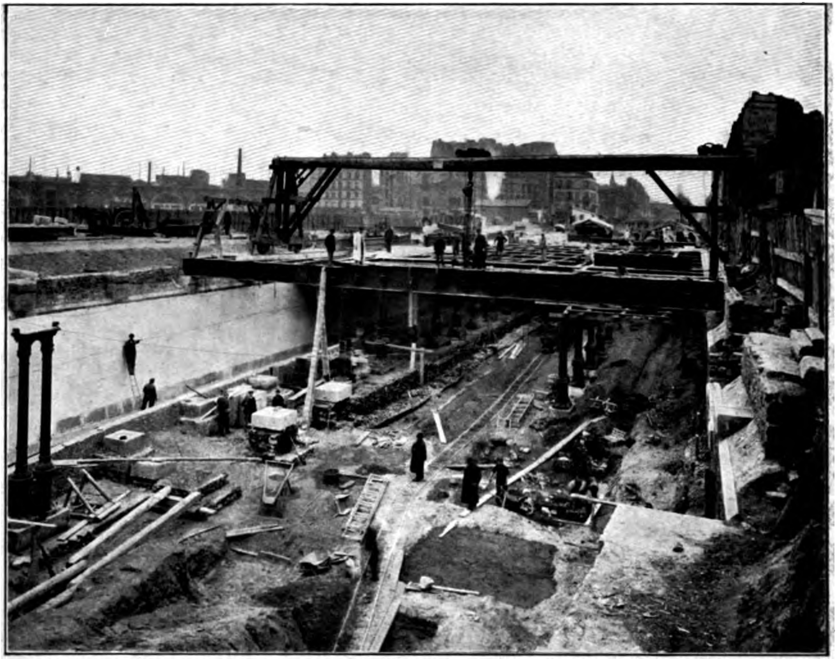
Two 750 kilowatt rotary converters.

The Moulineaux power house supplies current to the Invalides-Versailles Electric Railway, to the Western Railways Company, and to the Parisian Western Electric Tramway. Its plant consists of twelve-5,500-volt 25-cycle three-phase alternators, two of which are reserved for the exclusive service of the Metropolitan Railway. From these units, three-phase alternating current is supplied to the Etoile sub-station. Until quite recently it also supplied the temporary sub-station at the Champs Elysées which was equipped with two-750-kilowatt units, which will be removed to Bercy to complete the extension above mentioned.

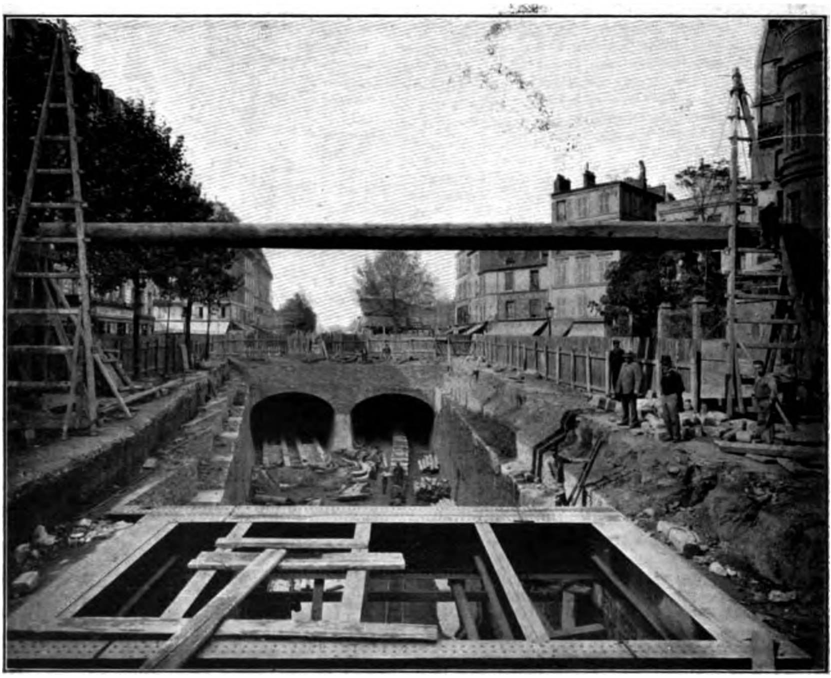


FINISHING THE COVERING IN, FEBRUARY 1903, OPÉRA STATION.

The equipment of the Bercy power house consists of Creusot dynamos driven by Creusot vertical compound engines. The Moulineaux power house, on the other hand, is equipped with Westinghouse alternating-current generators, direct-connected to Corliss engines built by the Dujardin Company, and to Garnier & Faure-Beaulieu engines. The Société Alsacienne de Constructions Mécaniques of Belfort has a contract for installing the steam plant, and the French Thom-

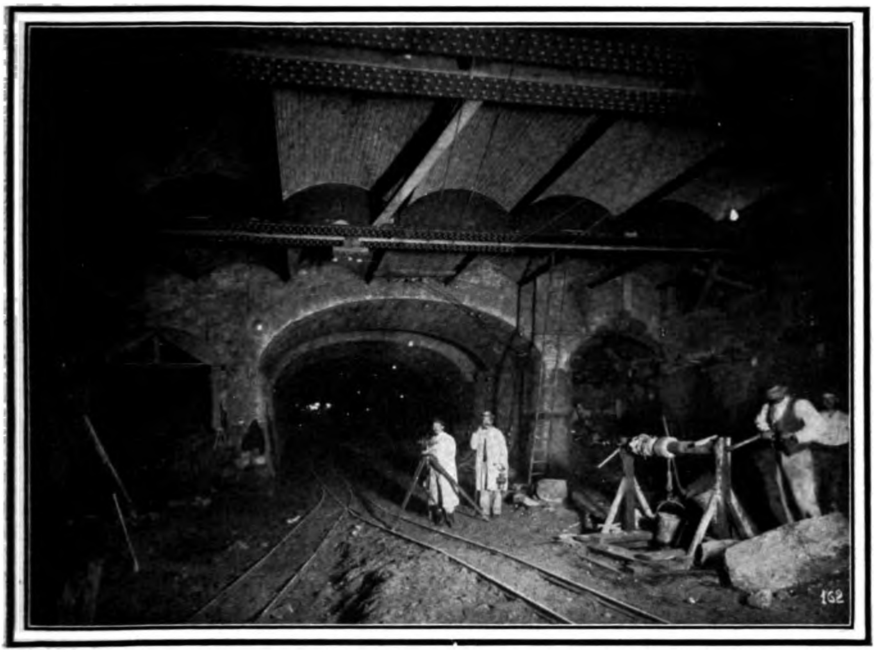


GARE DE LYON STATION. ERECTING THE STEEL ROOF.



BRANCHING POINT ON THE TUNNEL LINE OPPOSITE THE GARE DE LYON STATION.
Showing connection of tunnel with cut-and-cover work.

son-Houston Company, the electrical equipment of the Bercy power house extension. The equipment of the three-phase Asnières power house consists of alternators driven by horizontal engines, all built by the Société Alsacienne de Constructions Mécaniques.

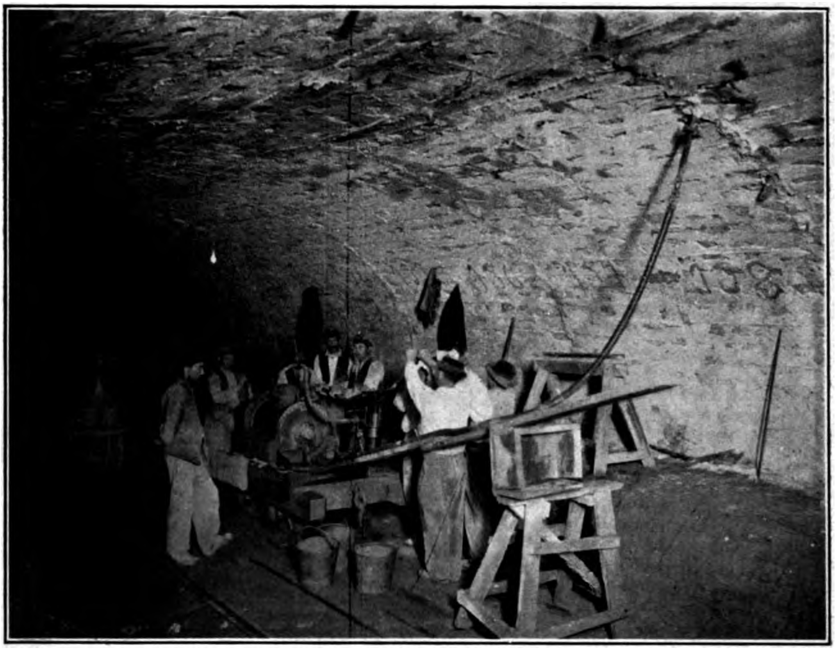


ENTRANCE TO TUNNEL, WITH CUT AND COVER WORK SEEN FROM BELOW.

Interconnections between the different primary lines from the three power houses have been so provided for that in case of an accident at a power house, any sub-station can be connected with any of the other primary lines, thus avoiding any interruption of service.

The distribution of load between the different power houses depends of course upon the demands of the Metropolitan Railway Company's traffic, regulated by economical considerations based upon the actual cost of the Metropolitan's own power house as compared with the cost of power under its contracts with the companies owning the auxiliary plants. It is needless to enter into a detailed comparison of load variations at each power house; suffice it to say that at the present time the total current supplied by the three combined power houses of Bercy, Moulineaux, and Asnières, at a pressure of 600-volts, direct current measured as at the sub-station, is stated to be about 4,700 kilowatts.

The sub-stations are designed on the approved style of construction in the United States; all the transformers and converters have been furnished by the French Thomson-Houston Company, with the exception of two Creusot transformers in the Bercy power house, and three Creusot transformers at the Etoile sub-station.



CONSTRUCTION OF THE TUNNEL. INJECTING CEMENT BEHIND THE ARCH.

In addition to the transforming station in the Bercy power house, which consists of two 750-kilowatt rotary converters in operation, and two 750-kilowatt machines in course of installation, with a direct-current set of 1,500-kilowatt capacity, the following is a list of the sub-stations on the system:—

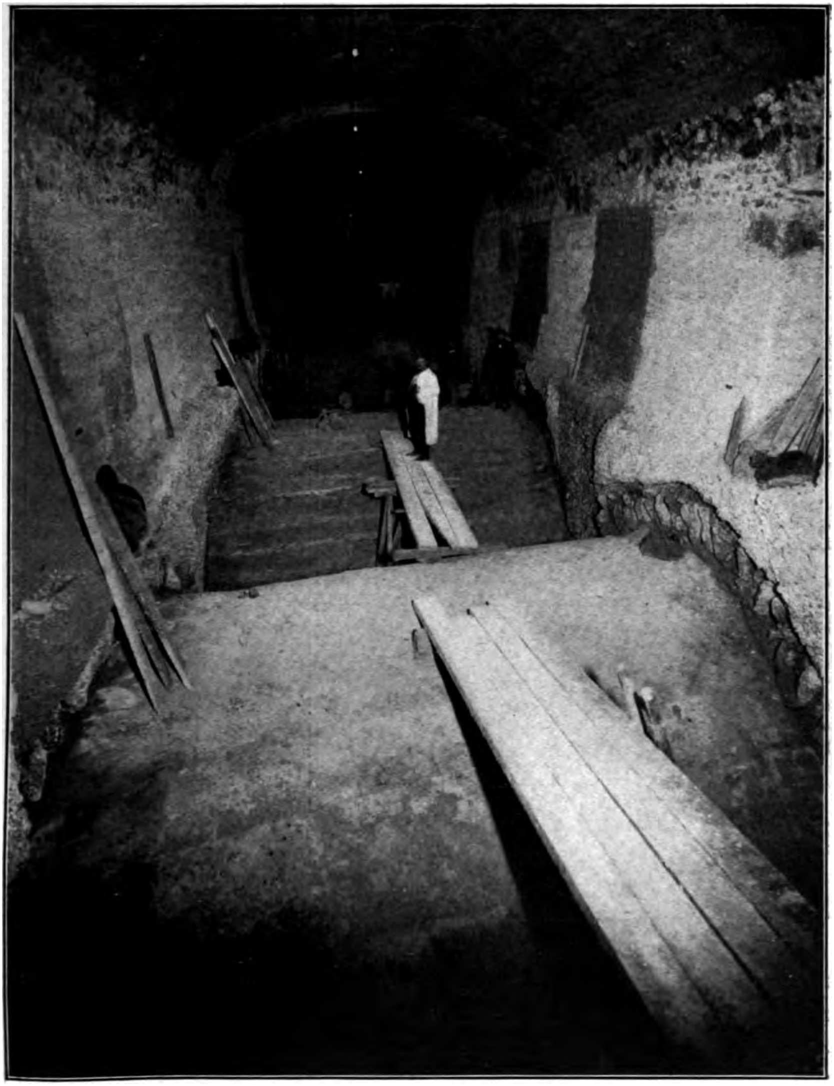
The Etoile sub-station, containing four 750-kilowatt rotaries, three of which are Creusot machines, and one Thomson-Houston.

The Barbes sub-station, with three 750-kilowatt Thomson-Houston rotaries.

The Père-Lachaise, with three 750-kilowatt Thomson-Houston rotaries.

The Louvre sub-station, with two 750-kilowatt Thomson-Houston rotaries.

Under normal conditions the Etoile sub-station is fed by the Moul-

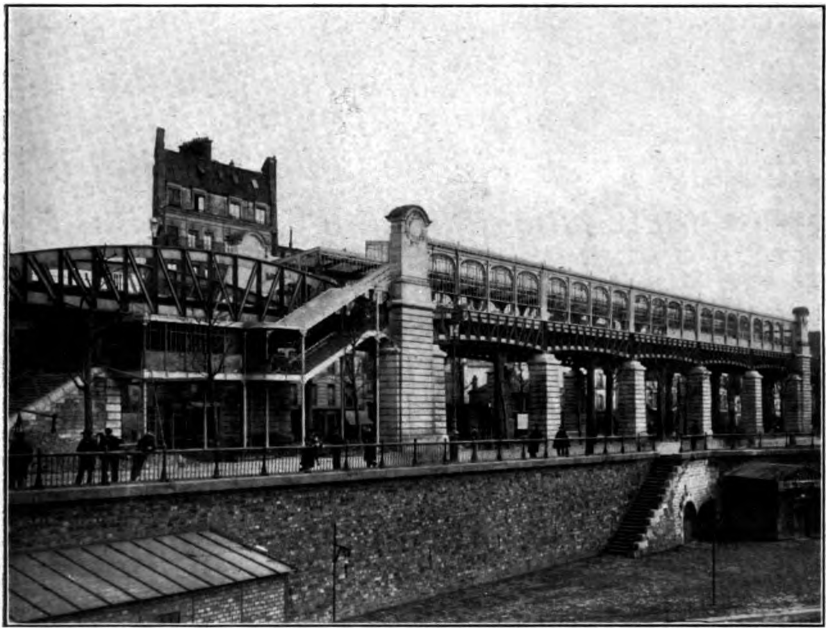


CONSTRUCTION OF THE METROPOLITAN TUNNEL ABOVE THE THREE ARCHES OF THE BATIGNOLLES TUNNEL.

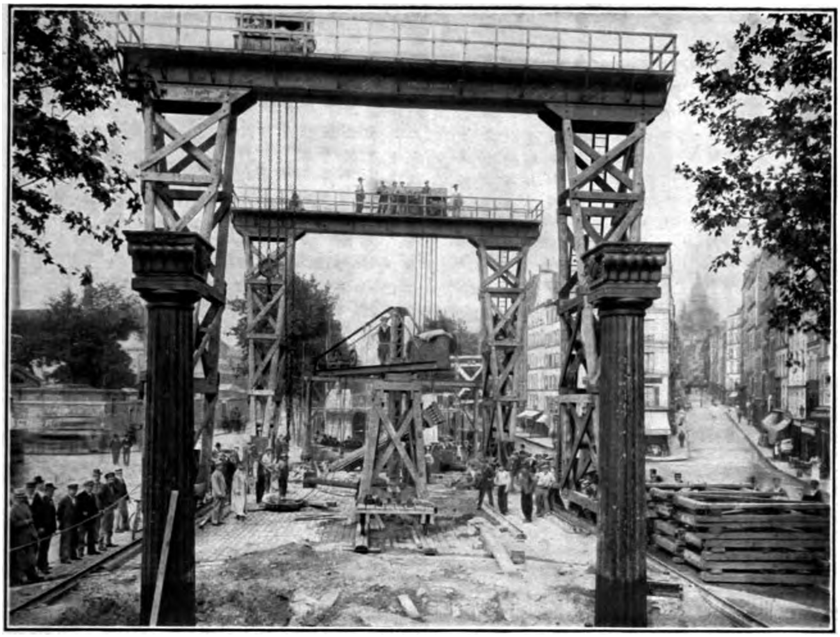
ineaux power house, the Barbes sub-station by the three-phase Asnières plant, and the Père-Lachaise and Louvre sub-stations by Bercy.

The large number of trains in service makes the use of storage batteries unnecessary. A storage battery was originally installed in the Etoile sub-station, which at the time was necessary owing to the few trains in operation, but with increased service it has been found that they can be entirely dispensed with. To-day the Père-Lachaise station alone is equipped with a 350-ampere-hour storage battery for the sole purpose of insuring a steady light service on trains after stops.

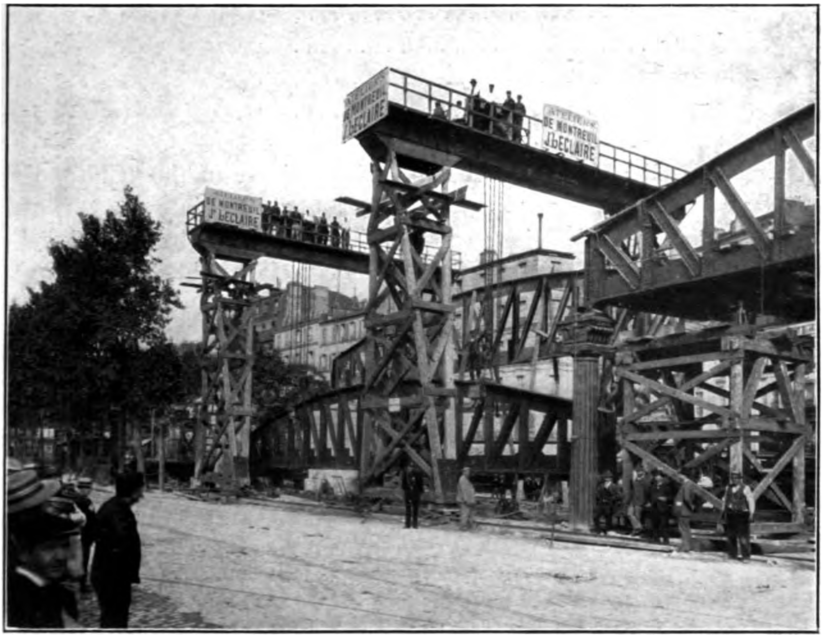
The wiring plan of the primary lines connecting the power house and sub-stations is very complicated and is not yet completely installed. At present the Metropolitan Railway Company is obliged to use, on one section, the cables that were laid for the Exposition of 1900, for the transmission into Paris of the three-phase current from the Asnières power house and of power from the Moulineaux plant to the sub-station installed at the Quai d' Orsay for the operation of the moving platform and of the little Quai d' Orsay railroad. The main feature of this complicated network of primary wires is the admirable provision made for the interchange of sub-station connections to any of the primary lines, which prevents the possibility of a tie-up on any part of the system due to an accident to any of the power houses. The feed wires carrying direct current from the sub-stations to the third rail are necessarily very short, as the former are all very close to the railway lines. The system is operated throughout by a third rail with track return.



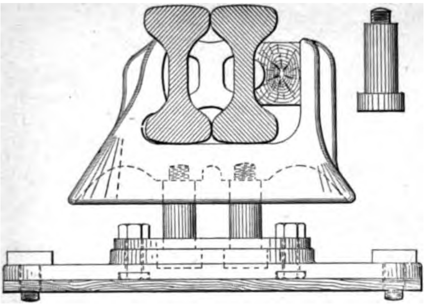
THE RUE D' ALLEMAGNE STATION FROM THE QUAI VALMY.



RAISING THE FIRST COLUMNS OF THE VIADUCT, INTERSECTION OF THE BOULEVARD DE LA CHAPELLE AND THE RUE MAUBEUGE.



PLACING THE GIRDERS ON THE COLUMNS OF THE VIADUCT.



INSULATOR FOR THIRD RAIL.
BLACKWELL TYPE.

The third-rail installation differs considerably in the cases of Lines 1 and 2. On Line 1, the insulator, which is of the Blackwell type, supports two conductor rails, as shown in the accompanying illustration. Insulation is obtained through the two supports, as shown, which are covered with an insulating material called "Aetria." On Line 2 the insulator consists of an iron cap covered with ambroïne, and supports one single third rail of a special composition. The accompanying illustration shows a cross section of the insulator and rail complete drawn to scale.

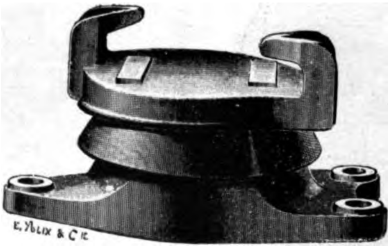
On Line 1 the same steel was used in the third rail as in the track rails, but in Line 2 a special third rail was made up of the following analysis:—

Carbon	0.15 per cent.
Manganese	0.55
Sulphur	0.035
Phosphorus	0.016
Silicon	0.06

having 7.54 times the electrical resistance of copper.

On Line 2 the bonds used on the third rail are of the "Chicago" type, 80 centimetres long, four to a joint, and riveted into the web of the rail. On the track, where greater elasticity is required, the bond is formed of strips of copper and its terminals riveted into the foot of the rail. On the track four bonds are used to each joint, the same as on the third rail.

Trains are operated in sections of four and eight cars; in the former case the forward car is the only motor car. In eight-coach trains both the forward and rear cars are motor cars, and can be operated separately or in series from the one controller. On some of the lines it is necessary to run trains with motor cars at both



INSULATOR FOR THIRD RAIL. PARIS METROPOLITAN TYPE.

ends, owing to lack of facilities for switching at terminal stations. Each motor car carries two motors that can be coupled in parallel. In the case of a double-ended train or where two motor cars are to be controlled simultaneously, these coupled motors can be operated in series by means of a connecting cable carried right through the train, and the reversing switches can be electrically controlled from a distance as in the Thomson-Houston multiple units. If it is desired to use only one of the motor cars, the other can be readily disconnected, and the two motors of the one car thrown into series-parallel.

The rolling stock itself is extremely light and all carried on single trucks. The motor cars are all second-class carriages. The trailers, on the other hand, are divided into first and second-class coaches, identical in construction, but differing in the appointments of their interior decoration. These cars are 8.70 metres long, 2.40 metres wide, and 2.30 metres high, with ten rows of cross seats set back to back, with the exception of the two end rows. A longitudinal aisle cuts through these rows, leaving on one side ten rows of single seats, 0.45 metres wide, and on the other, ten rows of double seats 0.92 metres wide, giving a total seating capacity of thirty passengers. There are two sliding doors on each side of the car, one serving as an entrance and the other as an exit.

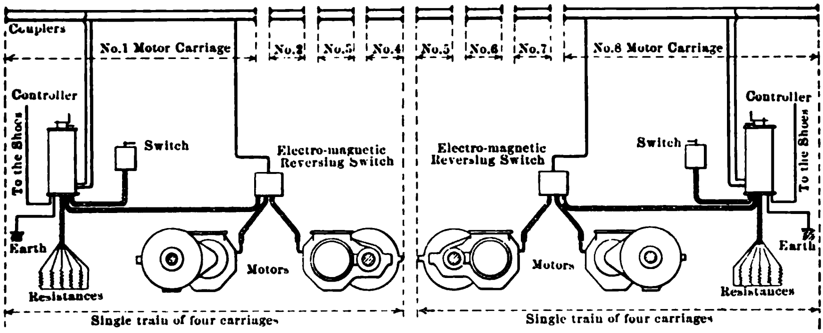


DIAGRAM REPRESENTING METHOD OF TRAIN CONTROL.

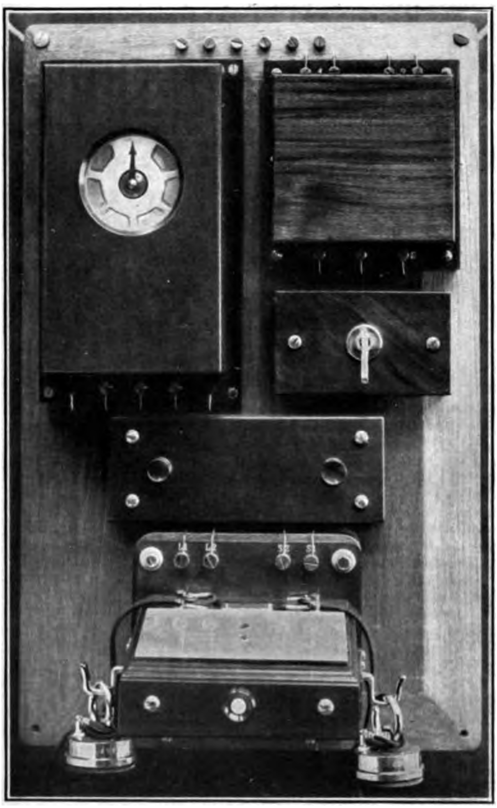
The cars are electrically lighted by six incandescent lamps in the ceiling and by four corner clusters. It is proposed to heat the cars electrically, and also to operate electrically a device for indicating the next station ahead. Neither of these improvements has yet been installed, however.

The temperature in the tunnel during the coldest season never falls below 10° centigrade; therefore, in view of the short rides, there is no real necessity for heating the cars.

In order to facilitate the riding of the cars on short radius curves, they are built with buffers at one end only. The end sills are also slotted so as to allow a lateral play to the couplers in going around curves. The road is equipped with the Hall signal system, insuring a safe distance of two electric blocks at a headway of two minutes between trains. A two-minute schedule has off and on been maintained, but it is not kept up at the present time owing to insufficiency of rolling stock.

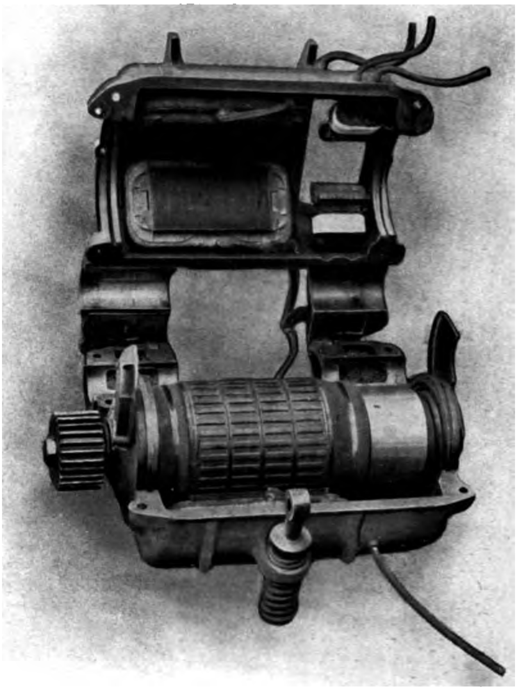
The subway is lighted throughout by electricity. Clusters of five 16-candle-power lamps each are spaced at intervals of 12½ metres on stations and platforms, and at intervals of 25 metres in the tunnel proper.

All stations, power houses, car sheds and offices are connected with one another by telephone on the Dardeau plan, which consists in connecting the different telephone stations in series on one same single or double line, from each of which interconnections can be effected between stations by means of a mechanical device, something like a clock, in which the turn of the hand or lever toward any given station shown on the dial gives the desired connection. This clock-work mechanism is wound by hand, each full winding providing for two thousand calls.



DARDEAU SELECTIVE TELEPHONE SYSTEM.

The car sheds and shops are about as inadequate as the rolling stock itself, additional storage room for cars having only recently been provided under the Place de la Nation Square. All repairs to rolling stock are looked after in the Rue des Maraichers shops, which

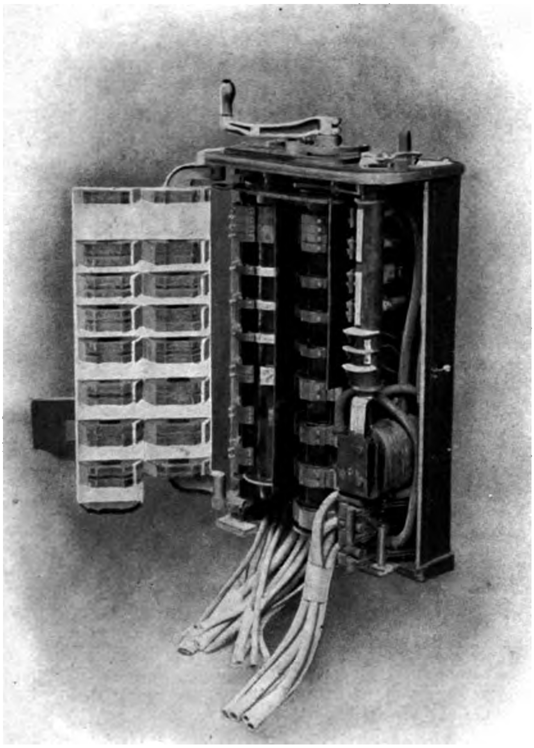


METROPOLITAN RAILWAY MOTOR

occupy a total area of 11,380 square metres, comprising:—one shed with a floor space of 2,250 square metres, in which are the machine shops containing iron and wood-working machinery, saws, planes, drills, etc., all electrically driven, the foundry, the paint shop, 70 metres of car pits, provided with the necessary cranes and hoists, and also the general offices of the company; a store room, which takes up part of the shed above mentioned and occupies an additional floor space outside of that building of 95 square metres; and a building used as living quarters of the station master and his assistant. The rest of the space is used as a store room for cars with a total trackage of 1,120 metres outside of the main operating tracks, of which 520 metres are under cover.

The fares charged on the Metropolitan Railway are francs 0.25 in first-class and francs 0.15 in second-class from any one point to another on the system. Up to 9:00 A. M., the second-class excursion tickets are sold at francs 0.20, the return ticket being good for the return trip at any time of the day or night.

These rates of fare, while comparatively cheap for long rides, are of course high for short distances; this, especially in the case of line 2, permits of a very appreciable competition from the surface road operated by the Compagnie des Omnibus, whose La Vilette-Trocadéro line, operated by steam, parallels the Metropolitan Railway's branch.



THE CONTROLLER, OPENED.

The fares charged on the surface road are francs 0.15 in first-class, and francs 0.10 in second class, with an extra fare of francs 0.05 for long distances.

The Compagnie des Omnibus, which operates the greater part of all the omnibus and tramway lines in Paris, came near losing all their traffic on this line when the Metropolitan Railway inaugurated its service on line 2, but has recently made a bid for public favor and has regained its patronage to a great extent by reducing its fares, by substituting steam for animal traction, by increasing its service from a fifteen-minute to a five-minute headway, and by introducing open cars on its line in place of the old-fashioned motor cars, which were already very much the worse for wear.

MANUFACTURING: CAPITAL, COSTS, PROFITS AND DIVIDENDS.

By Henry Hess.

Among the many contributions of lasting value in the literature of "Production Engineering" which The Engineering Magazine has had the privilege of publishing, this paper by Mr. Hess is probably one of the most important. It is an extension of the modern scientific study of manufacturing into the province of general commercial management. It applies the results of cost-finding methods to the ultimate questions of profit or loss in production. We are glad to announce that this initial article will be followed during the winter by further contributions from Mr. Hess extending the analysis to the effect of the principal wage systems upon the profits of the business as a whole.—The Editors.

IN order to get and to keep an intelligent oversight of the prospects and progress of any business, the first requisite is a basis of comparison. With a new venture this must needs be an estimate of expenditures and returns; with an already established business, the estimate is supplanted by records of previous experience.

For practically every line the volume of business is more or less proportional to the number of people employed, and, if a commodity is being produced, to the output per productive worker's hour. These two elements, therefore, will serve as the basis for a ready and comprehensive oversight.

A convenient method that also permits quick tracing of alterations in cost of production has been devised by the author and used with decided success and satisfaction; in explaining it a set of values are assumed for a hypothetical plant engaged in the manufacture of a line of special tools. The figures are entirely arbitrary and are not to be understood as serving any purpose other than that of general illustration.

Capital is employed, part of it in providing a plant in which and with which to produce the articles to be made, and a further part in starting the plant into operation; these two items make up what I term Total Fixed Capital. Further capital must be provided to defray current expenses incident to operation of the plant until such time as the returns from the sales render additions to this capital account unnecessary; capital so employed is aptly known as "running capital," and as it varies in amount with the number of productive hours, I prefer the more expressive, if longer, term "total variable running capital per productive hour."

This capital account is carried because profits are distributed as dividends to its total—at least in fact, though not always in name, when water has been diligently poured in to swell the bulk.

The other, and in the conduct of the business far more important main account, is that of costs; of these some are fixed and others again variable with the intensity of the output. The usual practice divides this account into three groups—material, productive labor, and expense—and considers the expense as directly proportional to the labor. Since, unless labor is expended, no material is used, it follows that the material charge also is directly proportional to the labor cost; in other words, if no work were done, no costs would be incurred. Reduced down to this, it is at once evident that the considerations underlying such apportionment are wrong. From this point of view I list as Total Fixed Costs all those items that are to be provided to put the plant in readiness,and as Total Variable Costs per Productive Hour all the remaining elements that may be reduced to a ratio with the productive hours.

The effects of the two points of view may be shown in another way: with all the costs varying directly with the time, they would be zero with a zero production and could be graphically represented by a line (such as that marked Total Variable Costs, in diagram Figure 2) starting from zero; the Total Net Receipts also start from zero; the vertical difference between the two lines represents the profits; thus apparently a profit is shown as soon as production is begun. It is, however, well known that at least a certain amount of production is necessary before a profit can be made. Instead of starting the total costs from zero, start them from point corresponding to the Total Fixed Expense (refer again to Figure 2) ; the result will be a crossing of this line with the Total Net Receipts line; this crossing will occur over that number of productive hours or men, or that weight of output, required to balance the costs. With a less output the business will be attended by a loss; with a greater output, a profit is to be expected. This matter has been entered into at some length as, though the importance of keeping general expenses down is generally recognized, the usual way of considering them as proportional to the labor leads to wrong conclusions that may, when production is low, give the impression of a margin of profit when actually there is a loss.

Following the tabular arrangement of the accounts given below, with their assumed values, a few further general considerations governing the apportionment of items of cost are given, more with a view to illustrate principles than to serve as a full enumeration.

Main Heads.

Costs		*Capital*	
Plant expense	$21,250	Plant	$179,200
To start plant	11,100	To start plant	11,100
Total fixed costs	$32,350	*Total fixed capital*	$190,300
Indirect expense per productive hour	$ 0.175	Indirect running capital per productive hour	$ 0.044
Direct expense per productive hour	$ 0.405	Direct running capital per productive hour	$ 0.101
Total variable cost per productive hour	$ 0.580	*Total variable running capital per productive hour*	$ 0.145

Detail Items.

		Real estate	$ 10,700
Building depreciation	$ 8,300	Buildings	55,300
Machinery "	10,300	Machinery	103,000
Pattern "	650	Patterns	2,600
Small tools "	900	Small tools	4,500
Interest, taxes, insurance	1,100	Interest, taxes, insurance	1,100
Total plant expense	$21,250	*Total plant capital*	$179,200
Initial commercial staff	$ 2,500	Initial commercial staff	$ 2,500
" engineering staff	1,500	" engineering staff	1,500
" power, light, heat	1,600	" power, light, heat	1,600
" unproductive labor	1,100	" unproductive labor	1,100
Unproductive material	1,400	Unproductive material	1,400
Advertising	3,000	Advertising	3,000
Total starting expense	$11,100	*Total starting capital.*	$11,100
Balance commercial staff	$ 0.033	Balance commercial staff	$ 0.008
" engineering staff	0.040	" engineering staff	0.010
" power, light, heat	0.027	" power, light, heat	0.007
" unproductive labor	0.053	" unproductive labor	0.013
Foremen and assistants	0.022	Foremen and assistants	0.006
Total indirect expense per productive hour	$0.175	*Total indirect running capital per hour of productive labor*	$0.044
Productive labor	$ 0.180	Productive labor	$ 0.045
" material	0.225	" material	0.056
Total direct costs per productive hour	$0.405	*Total running capital per productive hour*	$ 0.101

More or less latitude is necessarily given in the apportioning of the items to these groups. The distribution should be decided on as early as possible and then adhered to; this is more important than splitting hairs as to whether some item falls more logically under one head than another; changing about will vitiate all conclusions to be drawn from comparisons, and comparative analysis is the very essence of cost reduction. Above all things, the creation of an account or sub-head for miscellaneous charges is to be avoided; in time such a head invariably swells out of all reason and becomes a catch-all for all items that, by stretching a point, may be excluded from some group that needs a little phlebotomy to appear less apoplectic.

The various items cited are apportioned to the main heads under certain broad considerations that apply to costs as well as capital:

Fixed Costs or Capital:—Incurred or to be provided whether the plant runs or not; divisible into sub-heads, as:—

sums due to laying down the plant, even though it is never started;

sums required to start the plant into operation.

Variable Costs or Capital:—Incurred or to be provided during the operation of the plant, and varying proportionately to the number of productive hours or to the output; divisible into:—

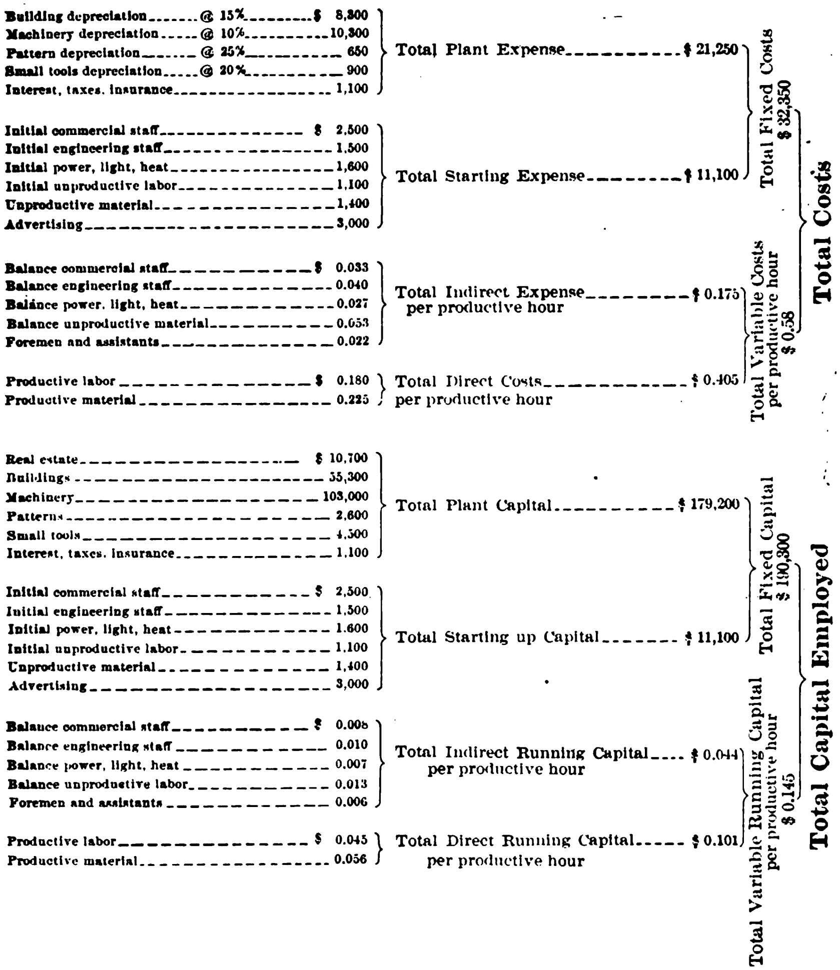
sums not directly chargeable to individual details of actual output, i. e., indirect expense;

sums directly chargeable to individual details of the actual output.

Productive hours refer to the time of the productive men—those actually employed on work that appears visibly in the final output. The term is really a misnomer, as it implies that workers of all other kinds are unproductive, a stigma that is decidedly undeserved, as such other workers are fully as indispensable as any to the furthering of the work as a whole; the term is in such general use that to substitute some other more in accord with the realities, would lead to confusion.

As not all the material used is visible in the final product, all not so visible is by analogy termed "unproductive" and therefore chargeable to the "indirect" accounts, while all that is weighable in the final product is charged as "productive" to the "direct" accounts.

The diagram, Figure 1, gives a comprehensive oversight of this grouping. The final detail items here given may be, and in most lines of work should be, still further analyzed; the farther such division is carried the more readily can an undue accretion of cost be located and corrected. Some caution in this respect is necessary to avoid carry-



Item	Rate	Amount	Group	Group amount	Subtotal	Total
Building depreciation	@ 15%	$ 8,300	Total Plant Expense	$ 21,250	Total Fixed Costs $ 32,350	Total Costs
Machinery depreciation	@ 10%	10,300				
Pattern depreciation	@ 25%	650				
Small tools depreciation	@ 20%	900				
Interest, taxes, insurance		1,100				
Initial commercial staff		$ 2,500	Total Starting Expense	$ 11,100		
Initial engineering staff		1,500				
Initial power, light, heat		1,600				
Initial unproductive labor		1,100				
Unproductive material		1,400				
Advertising		3,000				
Balance commercial staff		$ 0.033	Total Indirect Expense per productive hour	$ 0.175	Total Variable Costs per productive hour $ 0.58	
Balance engineering staff		0.040				
Balance power, light, heat		0.027				
Balance unproductive material		0.053				
Foremen and assistants		0.022				
Productive labor		$ 0.180	Total Direct Costs per productive hour	$ 0.405		
Productive material		0.225				

Item	Amount	Group	Group amount	Subtotal	Total
Real estate	$ 10,700	Total Plant Capital	$ 179,200	Total Fixed Capital $ 190,300	Total Capital Employed
Buildings	55,300				
Machinery	103,000				
Patterns	2,600				
Small tools	4,500				
Interest, taxes, insurance	1,100				
Initial commercial staff	$ 2,500	Total Starting up Capital	$ 11,100		
Initial engineering staff	1,500				
Initial power, light, heat	1,600				
Initial unproductive labor	1,100				
Unproductive material	1,400				
Advertising	3,000				
Balance commercial staff	$ 0.008	Total Indirect Running Capital per productive hour	$ 0.044	Total Variable Running Capital per productive hour $ 0.145	
Balance engineering staff	0.010				
Balance power, light, heat	0.007				
Balance unproductive labor	0.013				
Foremen and assistants	0.006				
Productive labor	$ 0.045	Total Direct Running Capital per productive hour	$ 0.101		
Productive material	0.056				

FIG. I. GROUPING OF INDIRECT AND DIRECT PRODUCTION ACCOUNTS.

ing the division to a point that gives the general impression of pettifogging to those whose duty it is to look after the apportionment of the items; once that idea takes root it will be almost impossible to enforce that consistent and conscientious apportionment that alone permits an analysis of value.

Most of the items enumerated are self-explanatory. Depreciation ought, if strict logic were followed, to be at first taken as a small portion of the total value of the plant and to be increased with each succeeding year as the wear and tear or general progress in the arts brings the plant components nearer to the end of their useful life. It is, however, more convenient to adopt a constant percentage, and this is also the more generally observed method. The ratio of depreciation should not be the same for all portions of the plant, but should vary with the probable average useful life; 15 per cent. for buildings, 10 per cent. for machinery, 25 per cent. for patterns, and 20 per cent. for small tools, are fair values. Many of the very strong European firms adopt the policy of practically "writing off" the value of their machinery, patterns, and small tools, or of carrying them on their books at valuations that merely ensure the presence of an account. The effect is a decrease in the nominal assets with, on the other hand, a very decided strengthening in the character of those assets that tend to improve that intangible, but none the less very real, asset of public confidence and credit.

That the capital employed to start the plant into operation is equal to the expense attending starting up is very evident.

As those items that vary directly with the output are incurred only as such output is produced and are again brought in by the sale of that output, the capital employed for these need not be equal to their annual sum total. Assuming that payments are made on an average of three months' time, the sum actually to be provided as running capital will not be greater than one-fourth of these annual expenses.

The usual practice values material on the basis of its weight, and labor and expense on the basis of the labor cost per hour; as the costs are so incurred this is logical. But total costs are made up of the sum of material and of labor and expense. For the purposes of the method of analysis to be set forth, the total as well as detail costs are compared and referred to the output, making their reduction to some common denominator necessary; that may be either their value referred to productive hours or to quantity of output; either form may be used as may be most convenient. If charges based on time are the more important—as in the production of most machines—it will be best to express costs as values per productive hour; but as many will find the reference to weight of output more convenient, both scales are used in the diagrams. In order to avoid large figures, productive men are substituted for productive hours on the basis of 3,000 productive hours per year equalling one productive man. In reducing material to values per productive man, it is assumed that experience has shown the average output per productive hour to be 9 pounds; this, at an average cost of 2½ cents per pound, makes the average cost of productive material per productive hour equal $0.225.

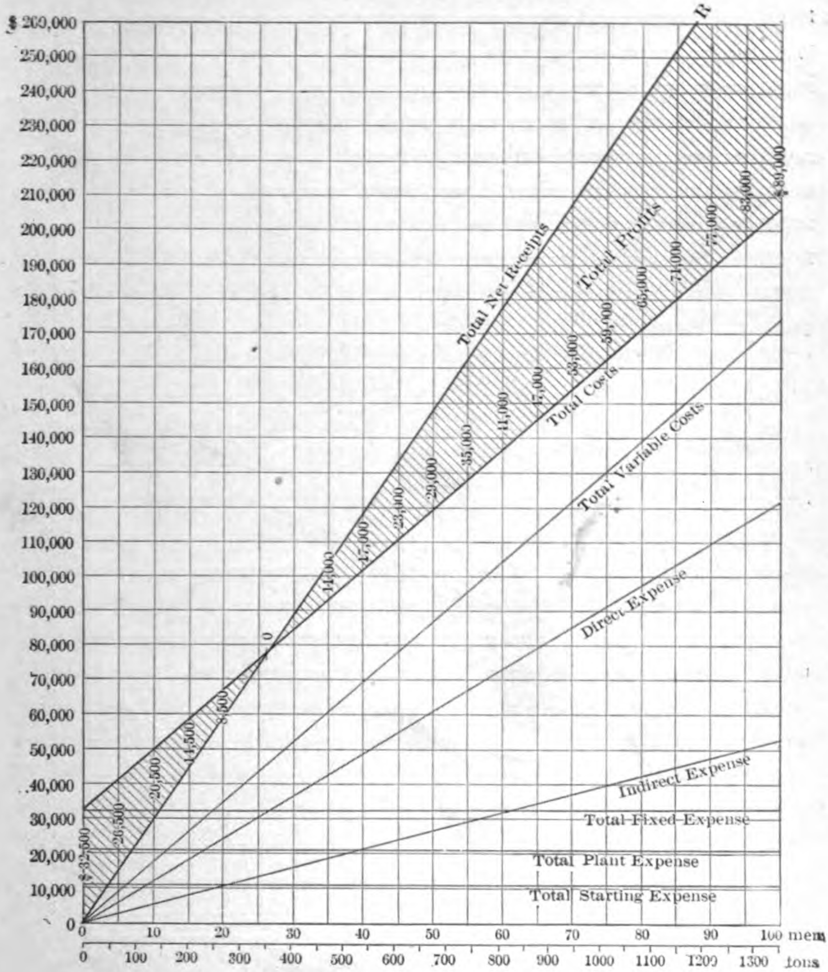


FIG. 2. COSTS, RECEIPTS, AND PROFITS.

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Plotting the various values tabulated above in relation to total productive hours, or rather productive men employed, counting 3,000 hours per man per year, as explained, will give a clearer insight into their mutual relation than can readily be obtained from the same figures marshalled in tables; see Figure 2. The thin horizontal lines are the Total Plant Expense, the Total Starting Expense, and their sum, the Total Fixed Expense. The slanting lines starting from zero are the Indirect Expense, the Direct Expense, and their sum, the Total Variable Cost. The sum of all of these costs is represented by a line start-

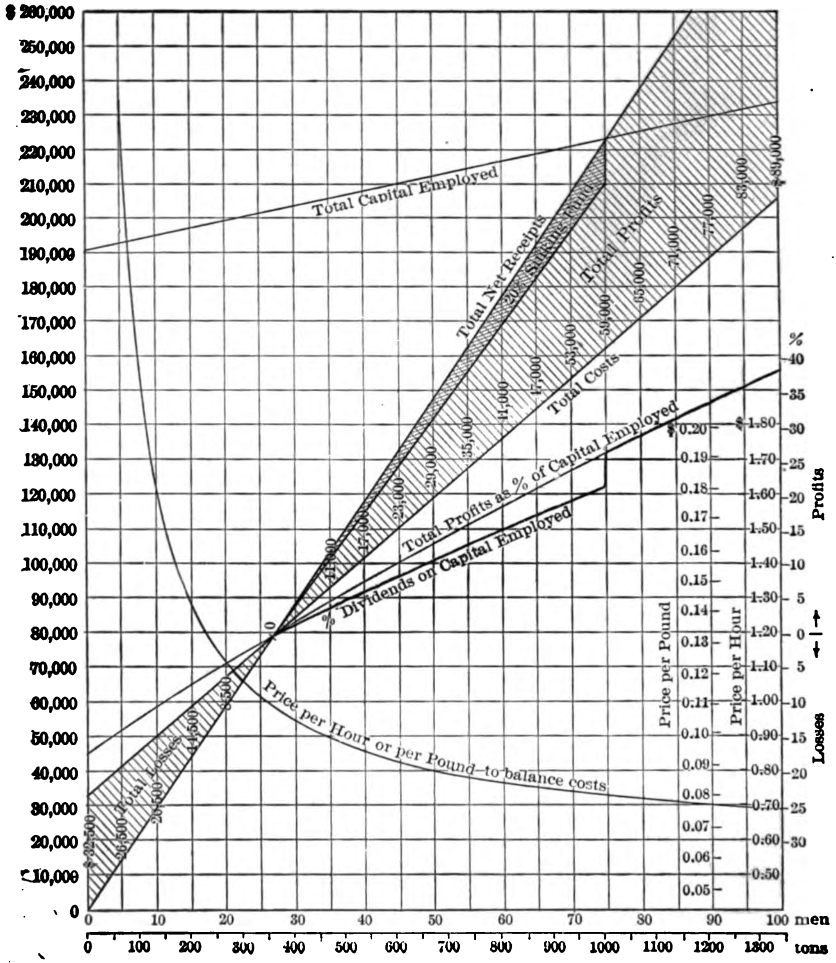

FIG. 3. CAPITAL, PROFIT, AND DIVIDENDS.
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ing from the sum of the fixed costs at $32,350 and running parallel to the sum of the total variable costs.

The output is sold at an average price of $0.11 per pound, and as the average output per man is 9 pounds per hour that means that the net selling price per productive hour is 0.11 × 9 = $0.99. The resultant total net receipts are represented by the heavy slant line. This line crosses the Total Cost line at 26 men, which indicates that at least 26 productive men must be fully employed if no loss is to result.

For any given number of productive men the prospective profit or loss is the vertical height of the cross-hatched surface. Thus for 50 men the profit is about $29,000; with but 15 men there would instead be a loss of about $14,500.

Such a diagram having values plotted in accordance with previous business results becomes very useful in forecasting probable profits or losses. For that purpose only it will be better to simplify it by copying in only the Total Cost and Total Net Receipt lines, Figure 3. As to many persons the weight of the product is a more familiar factor, a corresponding scale is added to the diagrams on the basis before used of 9 pounds per productive hour, reduced to short tons. This diagram then shows how many tons must be sold, or how many productive men must be kept employed, to pay expenses or to realize any desired profit. Writing in the profits and losses for each output, as shown, adds to the convenience of reading.

The various totals of the capital group are reproduced graphically in Figure 4; as the arrangement is quite similar to that already described in connection with the costs, no further explanation is needed.

The line representing Total Capital is entered also on diagram Figure 3; its crossing with the Total Net Receipts line shows that the total net receipts equal the total capital when 76 productive men turn out 1,030 tons of finished product.

Whether profits are good or poor will depend upon their ratio to the capital required to produce them, i. e., the dividends they represent; their relation to the capital is represented graphically by the line marked Total Profits as per cent. of Capital employed; see Figure 3. Were the entire profits distributed as a dividend, this same line would represent the amount of such dividend; it is zero at the point where the Total Cost and Total Net Receipts lines cross—when the works employ 26 productive men and turn out about 350 tons of finished product. A smaller force or output will result in a loss. With orders in prospect of about 1,030 tons, sufficient to keep 76 productive men employed, the dividend would be about 27 per cent., while the Total Net Receipts would balance the Total Capital Employed. With sufficient orders to employ 100 men the dividend would rise to about 38 per cent. on a total capital increased by only $12,000; this is less than the absolute increase in profits of $30,000. The diagram illustrates in a forcible manner the decided advantage of an active output in improving the dividend. Of course the same increase cannot go on indefinitely, as there comes a point when the production of a larger output is possible only by the provision of enlarged facilities and a corresponding capital increase.

It is not usual or good business to apply the entire profits to dividends, but first to reserve a sinking fund; the simplest arrangement diverts to this fund a definite fraction of the total profits; very often, after the fund has reached a certain height it is simply maintained at that height, leaving all profits beyond to be distributed as dividends. Say that 20 per cent. of the profits are devoted to the creation of a sinking fund up to a total of $12,000, which is 20 per cent. of $60,000; that portion of the profit surface of the diagram Figure 3 that is double-hatched includes the sinking fund; the single-hatched portion indicates the remaining profits available for distribution as dividends. Up to the time that the sinking fund is no longer increased the dividend is less than the total profit; beyond that the two are equal. The heavy line marked 0/0 Dividends on Capital Employed gives the latter for any number of productive men or tons of finished product. These figures are all based on the actual capital employed; if the nominal capital is larger the dividends on that nominal capital will of course be proportionately smaller.

In times of very close competition, or indeed always, it is useful to know what average price must be realized to balance the costs. It is evident that when the number of men employed is small the cost must be relatively high and, *vice versa,* a large force is attended by a relatively small cost. The curve drawn in on the diagram Figure 3 shows this very clearly; for instance, with a force of 90 men turning out about 1,220 tons, $0.70 per hour or $0.077 per pound will barely cover the costs, but it takes $0.94 per hour or $0.105 per pound when there are in hand orders for only 400 tons, enough to employ the smaller force of 30 men.

All that has been said so far applies to the forecasting of the results of an existing business or of one to be established; but the methods are useful also for following up costs in detail and for pointing out the essential relation and importance of the various elements of cost and so showing where effort must be applied to bring about those economies that count most.

Forecasting is quite useful, but far more important is it to make sure that results agree materially with such forecasts and to find the causes for whatever divergencies there may be. For this purpose the lines laid down in the diagrams may be considered as scales by which actual results are measured. There is nothing new in the idea of following up costs in detail and by groups and comparing these with some ideal; rarely do the results agree with that, and very often are discrepancies attributed to the influence of a fluctuating output; there

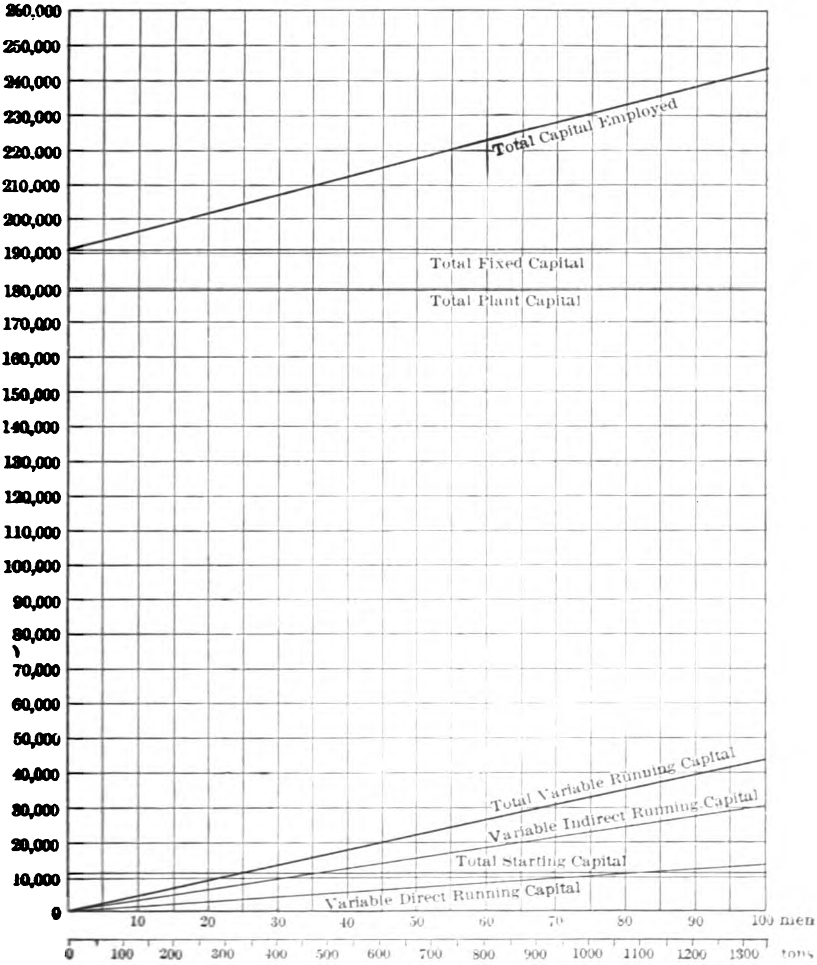

FIG. 4. CAPITAL EMPLOYED.

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is generally just enough truth in that excuse to prevent the responsibility for a falling off being definitely located, owing to the haziness of knowledge of the actual influence of such fluctuation. Since with lines as here laid down the costs are entered vertically over the output weight or number of productive men employed, the influence of fluctuation is considered and eliminated as a disturbing factor in the costs. The diagram Figure 2 might be employed for this following up of the costs, but for the fact that the small scale of the vertical values renders close reading too difficult. A couple of items of cost are used in illustration of the principle and entered on a diagram, Figure 5, to a la-

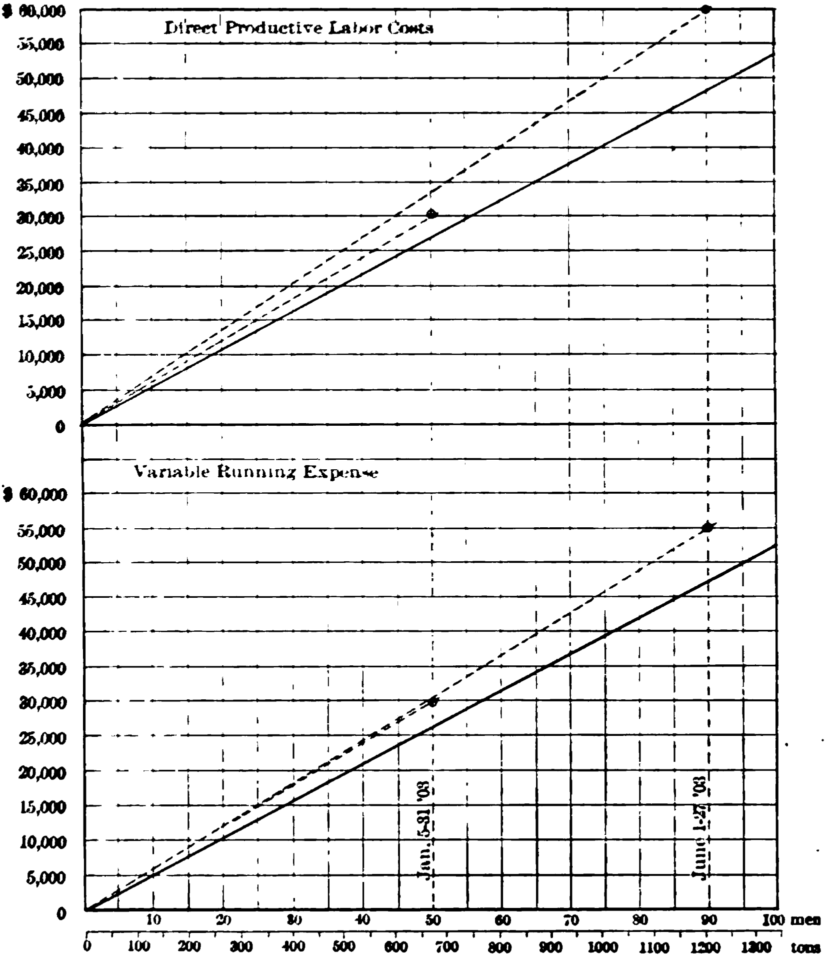

FIG. 5. IDEAL AND ACTUAL COSTS.

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scale; in order to avoid confusion of entries it is desirable to have but one line on each portion of the diagram. The variable running expense and the direct productive labor costs have been selected in illustration. Entries for comparison should be made at regular and frequent intervals of time, say once each four weeks, and not later than the third day of the first week of each period; four weeks, rather than a month, is suggested as the better period to avoid the influence of the varying number of working days per month. Either the weight of output or the number of productive men during the time under consideration is used on the horizontal scale; the number of productive men is the total number of productive hours worked divided by the normal number of productive hours per man in four weeks; thus 4,800 hours at 60 hours per week, or 240 hours in four weeks, gives 4,800 ÷ 240 = 20 productive men. Say that from January 5 to 31 there were 50 productive men employed, and from June 1 to 27 there were employed 90 men; vertical dotted lines from these numbers are carried over the diagram and marked with the date; on these lines there are entered the actual costs for these periods. A glance shows that the desired results were not reached during either period; as all of the entries fall above the lines, they indicate too high costs; moreover, light lines drawn from the actual results to zero show that the results in June were decidedly inferior to those of January, with the difference not so large for the variable running expense as for the direct productive labor. It may be that this indicates that the larger number of men employed during June is too great for the existing shop staff; but whatever the cause, this falling out of line calls forcible attention to the need of a search for that cause. In cases of notable divergence, either of deterioration or improvement, it is well to enter opposite the entry the reason for such divergence; with time such entries form a very valuable aid to the reduction of costs.

Nor need a search for the reason of a divergence be a difficult or blind one; carrying out the principles laid down, using further comparative lines for the various sub-items of cost, will readily locate those items responsible for the change. Nor is it necessary to start out at once with a very large set of detail items; rather will it be advisable to begin with groups, carrying the analysis of such groups into detail as the need for investigation develops. A useful arrangement brings the whole series of comparative diagrams vertically in line, as shown in Figure 5; this allows the record for a given period to be followed up very quickly by tracing along the vertical dotted line marked with the date to see where wide departures occur.

The work involved is not great, consisting merely in the arrangement shown of data already in existence; this can be readily done by the ordinary office force; but it will greatly aid the always busy and usually overworked man at the helm to a more comprehensive and accurate survey of the entire working of all the various departments, to a correct appreciation of their interrelation and interdependance, and to the location of the responsibility for good and poor results, with less work on his part than any other method I am familiar with. It is applicable to any line of business or manufacture, whether on a large or small scale, so long as the operation can be reduced to comparison with some general factor, such as output or labor.

THE TRAINING OF APPRENTICES IN AN ENGINEERING WORKS.

By C. E. Downton.

According to many well informed and serious thinkers, one of the very pressing problems in modern industry is the supply of proper recruits to the ranks of the workers. In the rapid changes of the last few years the old order of apprenticeship and training has been of necessity discarded, while as yet little has been done toward supplying its place. There is therefore especial value in the study of the systems which have been devised to meet the new conditions, by a few of the farthest and clearest sighted managers, and we hope to follow Mr. Downton's account of the Westinghouse methods by like descriptions of the systems of some of the most successful works in allied engineering lines.—The Editors.

WE have to revert only to the beginning of the last century to find the arts buried in empiricism and the sciences just emerging from a state of probation. Active minds, however, naturally inclined to be analytical, were already collecting data and establishing the laws of cause and effect, and it was not long before the sciences, developing a practical value, became incorporated in the industrial arts and the latter began their wonderful advance which has separated the nineteenth century from the past by a gulf too broad to be spanned even by the most comprehensive imagination.

In this marvelous development, there came into existence the technical school, and from its rapidly expanding doors there has gone out into the ever widening field of industry a vast army of workers, each of whom has been more or less efficiently equipped for participation in the progress that has marked as an epoch the time referred to.

From a careful observation of the qualifications of these men and a study of the methods of their preparation for active service, there gradually evolved a consensus of opinion among pedagogues that there must be a blending of theory and practice to bring about efficient achievement; yet how this blending should be most successfully accomplished still is, and for many years to come will continue to be, a prolific source of fruitful discussion.

Many men who started in the ranks of labor, appreciating their deficiencies, later took courses in the technical schools and, thus fortifying their lines of weakness, have quickly mounted the ladder to fame and fortune. Others who had in early life laid a broad foundation to their education in the classical and technical schools, later began at the lowest rounds of that same ladder and by their superior mental equipment have distanced in a comparatively short interval those with whom they were competing in the race for preferment.

The technical schools, recognizing the benefits that would accrue to·their students from a systematic combination of theory and practice, have introduced systems of manual training in their courses with more or less successful results, depending upon their individual conception of the idea and the practical application of its principles.

On the other hand, however, industries developed more rapidly than recruits to their ranks could be provided by the technical schools. In fact, a natural sequence of events required the new vocations to develop to a certain degree before the technical schools could recognize their existence and prepare to educate students for participation in them. Thus has come about a return to the system which existed before the advent of the technical school, where an industry gained accession to its ranks by giving instruction of its own to those who desired to enter its special field of activity.

In the days when empiricism swayed the arts, their secrets were transmitted from father to son or from man to boy through a long and tedious course of training, which finally became systematized into courses of apprenticeship of a certain number of years' duration. The adaptation of this system to our present industries takes into account the strides which have been made in modern systems of education, in which the fundamental principles of the sciences have been incorporated and thereby the time of service has been much abbreviated.

Among those industries which have required a rapid augmentation of their forces, much thought has been devoted to the development of a modern system of apprenticeship. There has been an earnest effort born of necessity to prepare young men so that they may be fitted to fill competently vacancies that occur from time to time in their working organization.

The continued efficiency of any industrial enterprise is dependent to a great extent upon the degree of intelligent familiarity with the nature of the product and skill in methods of manufacture, which is possessed by those employed in the operations necessary to fabricate the finished output. Although the technical schools are doing a commendable service in turning out great numbers of students technically and scientifically trained, still the latter seem to be deficient in that degree of working knowledge that qualifies them to be of immediate use in the industrial organism. It is in the nature of things beyond the scope of any university to supply the practical experience which will mature men for efficient service immediately upon leaving.

The conditions under which students are given their shop training at college are far from those actually existing in commercial practice. Such training can at best be elemental in preliminary preparation for any of the various lines of industry which the many students may eventually select. At this early stage of his development, a boy has very vague ideas regarding the particular branch of work for which he has a natural taste and aptitude, and the college work, being of a primary nature, is not of much service in aiding him to determine whether he has special qualifications for pure engineering, for constructional design, or for executive management.

It is generally conceded, therefore, that college work should be supplemented in the industrial field by some sort of an apprenticeship service which will give the graduate, under the most favorable environment, a systematic training in shop methods and familiarity with the practical uses of materials. Actual work in the shops of a commercial enterprise also affords an opportunity to learn how men are handled. This kind of experience can only be obtained by becoming part of the organization and being subject to its routine discipline. By entering into active service fresh from college, while the mind is alert and impressionable, the graduate is qualified to work with a degree of appreciation far beyond that of the novice who has had no technical training. His senses are keen, and, by observation and actual performance, he is able to absorb a great amount of information in a very short time. Every operation is easily grasped, owing to his familiarity with scientific data and technical theory, and his ambition is inspired to prove that his knowledge can be of service.

There is no line of modern commercial activity which has developed as rapidly as the electrical industry, and it is here, therefore, that there has been a great necessity for an apprentice system, to serve as a source of admission to its ranks. I have been so fortunate as to have been identified with the development of such a system in the works of one of the largest and most progressive companies in this line, and the methods of instruction there adopted may be considered as fairly representative of the result of the best thought put into effective operation.

Prior to January 1896 there was no regularly organized apprenticeship system in vogue at these works. From the young men who then entered the shops to learn the practical side of the business, no requirement was exacted in advance as to specific qualifications for the work they were about to undertake. Technical graduates and others were treated exactly alike as far as the course of shop training was concerned. No systematic schedule existed for transferring an apprentice from one department to another. The number of departments through which an apprentice would pass in a given time was dependent largely upon his degree of liking for a certain class of work and the impatience evinced to leave it, or the desire shown to continue in it.

This arrangement was haphazard in its working and did not, of course, insure to either the apprentices or the company the very best results. Ability was not always recognized as the qualification necessary for advancement, as it should have been, modesty, a characteristic which is often associated with ability, frequently acting as a detriment.

Later, as the works grew in size and the number of apprentices increased proportionately, a more efficient organization was established and a separate department formed for the purpose of keeping track of their welfare, and the results so far have proved very satisfactory.

There are now two distinct courses, one for non-technical and the other for technical graduates. The first has been named "The Ordinary Apprenticeship" and provides for intelligent young men who desire to learn the machinist's trade. It is the object of the company to train, from those who take this course, men skilled as mechanics, foremen, and inspectors. This class of apprentices does not progress through the works from one section to another, for it is not intended to give them a general knowledge, but rather a specific training in the manufacture of a definite line of work. Each is put at that class of work for which, after close inspection, he shows himself to be best adapted, and, with the possible exception of about six months spent in the drawing room, remains there throughout his entire course. Each of the sections referred to is practically a complete machine shop, fully equipped with all kinds of tools, which in character are similar to those of the other sections, but vary in size, owing to the difference in dimensions of the product manufactured. The character of experience obtained in any one of them, therefore, yields an acquaintanceship with a general line of shop practice.

This method of treatment has been found to work well with this line of apprentices, for the reason that the individual not only becomes familiar with the various machine tools, but works under the most favorable conditions through a long and constant association with the same men and foremen who know his capabilities and take a continued interest in his welfare. He here passes through a course of filing and chipping, and then progresses to the operation of machine tools, beginning with the drill-press and taking up in turn the shapers, lathes, planers, and vertical milling machines, finally arriving at armature winding, armature-core building, and assembling of parts and complete machines.

Thus at the end of his apprenticeship service, he is prepared to accept almost any responsibility that would fall to the lot of the skilled mechanic, and, through his perfect identification with the section and his familiarity with his surroundings, becomes inspired with that confidence which is necessary to place a man at the best.

In some cases where special qualifications are shown, through application and study, apprentices are given opportunities in the testing and engineering departments.

A trial period of 685 hours, or approximately three months, is required before the apprentice is allowed to become indentured. During this time he has an opportunity to study the situation thoroughly and is able to come to an intelligent conclusion as to whether he will pursue this calling as his life's work, and it also gives the company a chance to decide whether he is desirable timber upon which to spend time for further development.

The minimum age limit for entering this course is seventeen years, and the compensation and length of service are as follows:

	Years in Course	Hours per Year.	At 17 Years.	At 21 Years.
1st	First 3 months	685	5 cents per hour	5 cents per hour
	Last 9 months	2,055	8 " " "	10 " " "
2nd		2,740	10 " " "	12 " " "
3rd		2,740	12 " " "	15 " " "
4th		2,740	15 " " "	

The apprentice is paid time and one-half for all overtime, and if he completes his course to the satisfaction of the company, is given as a gratuity one hundred dollars and a diploma.

Precedence for vacancies in the corps is given to young men in the works who desire to learn the machinist's trade. At the present time, the number of applicants from this source exceeding the vacancies that occur, access to the corps is closed to those not employed in the works.

Another course, called the "Engineering Apprenticeship," provides for young men who are graduates of technical schools and universities. This is of 5,616 hours, or two years duration, 16 cents per hour being paid for the first 2,808 hours, and 18 cents for the remainder. A trial term of 685 hours is required before acceptance in

as in the case of the ordinary apprenticeship, a system of in-

ENGINEERING APPRENTICES AT WORK IN THE ARMATURE-WINDING DEPARTMENT.

denture being in force thereafter. Great care is taken in the selection of men for this work. Every endeavor is made to obtain the highest class of graduates from the leading technical schools; the co-operation of the professors is solicited, and their recommendations are given careful consideration before the applicant receives any encouragement.

Application blanks must be filled out in the hand-writing of the applicant, giving name and address of the father or mother, or if they are deceased, of guardian; also the date of birth of applicant and the names and locations of schools attended, with a statement of the nature of the school education, name of university attended and course pursued, degrees received, references to professors or others, and a statement of subsequent practical experience, if any.

It does not seem to be the best policy to confine a technically educated apprentice to any particular department of the works for a period longer than is sufficient to fix well in his mind the methods involved in the construction of the mechanism there produced, and there is by no means a desire to keep him at a particular operation until he becomes a skilled mechanic. The aim is rather to familiarize him with the practical application of the elementary principles of the sciences, which he has already studied, so that he gradually becomes accustomed to think along mechanical lines. It is like learning a new language. No matter how much it may be studied, it cannot be thoroughly acquired for practical service until daily association with others who are speaking it so accustoms him to its use that he finds he can think in it.

So in this advanced course, the apprentice, besides devoting somewhat over one-half his time to the shops, is placed in the engineering, construction, testing, and correspondence departments. In fact, his opportunities to become thoroughly familiar with the latest engineering practice are of the very best, and he is assisted and encouraged at all times to select the branch of work he desires to pursue.

TESTING AN ALTERNATING-CURRENT GENERATOR.

Constant vigilance is being exercised to discover those who show exceptional appreciation of the work, and it is easily possible for a young man to prove his worth and receive compensation proportionate to his value to the company, after he has served only a small fraction of his apprenticeship term. This opportunity acts both as an incentive and reward to the hard worker, for he feels that the time of preparation for his life work can be shortened materially by constant application and attention to duty.

Fairness in handling such a body of young men is a first consideration with the company. A properly scheduled course in the shops, with this object in mind, has been the means of bringing about most excellent results to all concerned. Each apprentice feels that he is placed on an equal footing with the others; rivalry urges each to make the most of his time in a department.

The time and work are divided in a manner dependent upon their relative value to the apprentice. As little as one week is spent in some departments, while in others six months are considered desirable. Best practice indicates that experience in the department where apparatus is finally tested before shipment should come near the end of the course, as a thorough understanding of the apparatus as a whole should be obtained before the apprentice is allowed to operate it. In case of some defect, he is able to state its nature exactly, and in many cases a fault is discovered before a machine is put on test, thereby saving considerable time, and in many cases avoiding damage. The course strengthens confidence and develops perspicuity, which is lacking in those unfamiliar with the construction of the apparatus they are called upon to test.

THE ENGINEERING APPRENTICES. MR. DOWNTON STANDS IN THE RIGHT FOREGROUND.

Means have been adopted to study the capabilities of each apprentice and to encourage him in his work, both through personal observation of the foreman in charge of the apprentice department and by reports from the foremen in the shops. The latter are of two kinds: first, those in the nature of complaints regarding inaptitude for the work and for non-interest or mis-conduct, and are made at any time the foreman feels it is necessary; and second, those coming at the end of service in a department, being in the nature of a recommendation on account of special qualification or for diligence. A set form for these reports is used, giving the foreman an opportunity to set forth the qualities of mind and character which he has observed in an apprentice and outlining the channel in which it is thought his energies should be directed in the future. The obligation to make these reports causes the foremen to take an observant interest in the apprentices, since his own qualifications as a judge of character and qualifications, and his ability to impart information to others, are at stake. His sense of responsibility for the future welfare of those in his charge is also developed, and a conscientious foreman will use every endeavor to study their characteristics and to lend encouragement to pursue the course, or the reverse, according to his intelligent conclusion as to their possible future development.

In order that the foreman in charge of the apprentice department may keep in touch with the work done by the apprentices, each is required to make a daily report, stating the nature of the work of each operation performed, and the time spent in its accomplishment. This statement is confirmed by the foreman and forwarded to the apprenticeship department where it is systematically recorded.

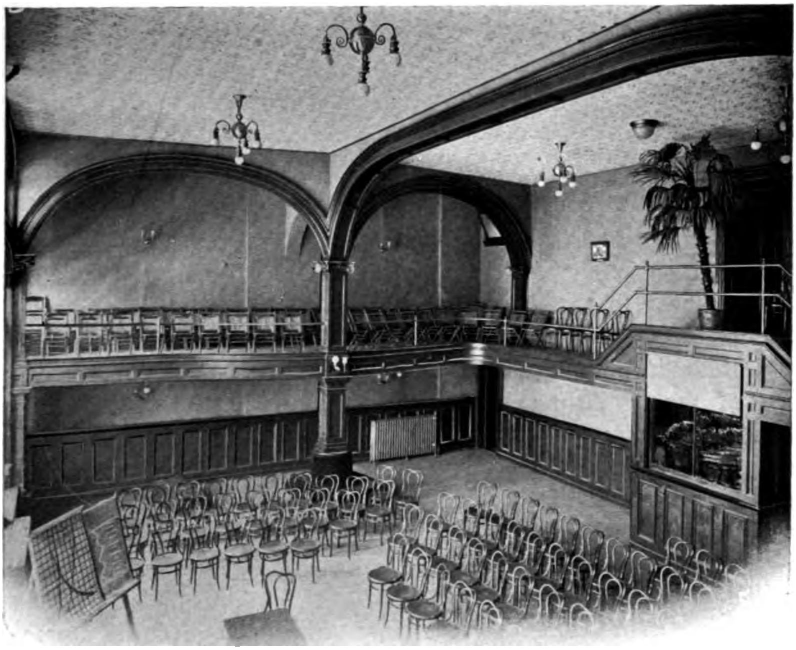
From a careful study of these reports an intimate acquaintanceship with each apprentice is obtained, and in a comparatively short time much knowledge is gathered which becomes of use in selecting men for positions with the company, according to the work which they are most capable of performing.

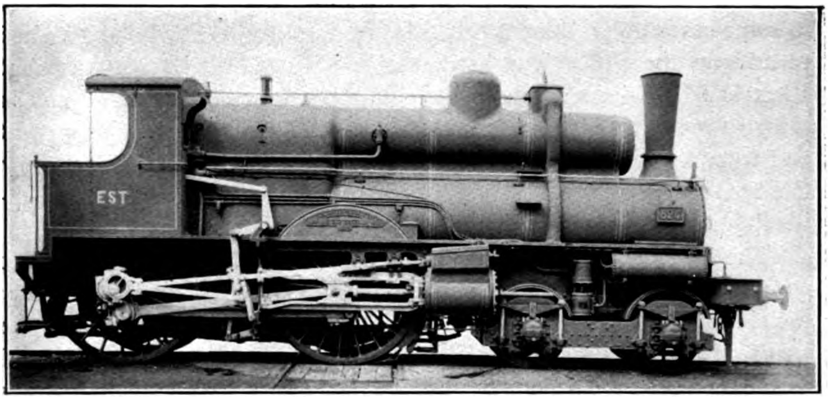
An effort is also made to inspire the apprentices with a common interest in their work. This leads to an open and free interchange of ideas and develops a quality of frankness which affects their whole career. It is made apparent that it is inadvisable for an employee to be reticent in order to retain his standing with the company. A general feeling of co-operation has resulted, which a year or so ago crystalized in the formation of an organization called The Electric Club.

The Electric Club is an organization entirely separate and distinct from the company itself, although its membership includes nearly all the apprentices, engineers, and every member of the management of the Westinghouse Electric & Manufacturing Company. Its object is to foster physical, mental, and social recreation, but the educational features are most prominent.

Apprentices are encouraged to organize small clubs for the discussion of the details of electrical apparatus, and as a means for obtaining answers to questions upon difficulties that arise during working hours. The engineers of the company attend these sections to lend encouragement and reply to questions. Lectures, both technical and general, are delivered on two evenings of each week, except during the summer months, by the engineers connected with the company, and in some cases by prominent practitioners in other lines who are invited to address the club. The local section of the American Institute of Electrical Engineers meets in the club rooms once each month, and in return for the privilege, members of the club are invited to be present and to participate in the discussions. A well equipped reading room has been provided, well adapted to the purpose. All the leading technical journals and current magazines, are accessible at all times.

The assembly hall, shown below, has a seating capacity of 250 persons, and besides this, there are seven other rooms used principally for class and section meetings. Social gatherings, encouraged by the wives of the engineers and officials of the company, are frequent and most enjoyable. The young men become associated in this manner with the very best people of the community. Such gatherings are thoroughly informal and attract the young men, who in many cases are of limited means and obtain but few opportunities for enjoyments possessing influences of an elevating and refining nature.





LOCOMOTIVE WITH DOUBLE BOILER, EASTERN RAILWAY OF FRANCE.

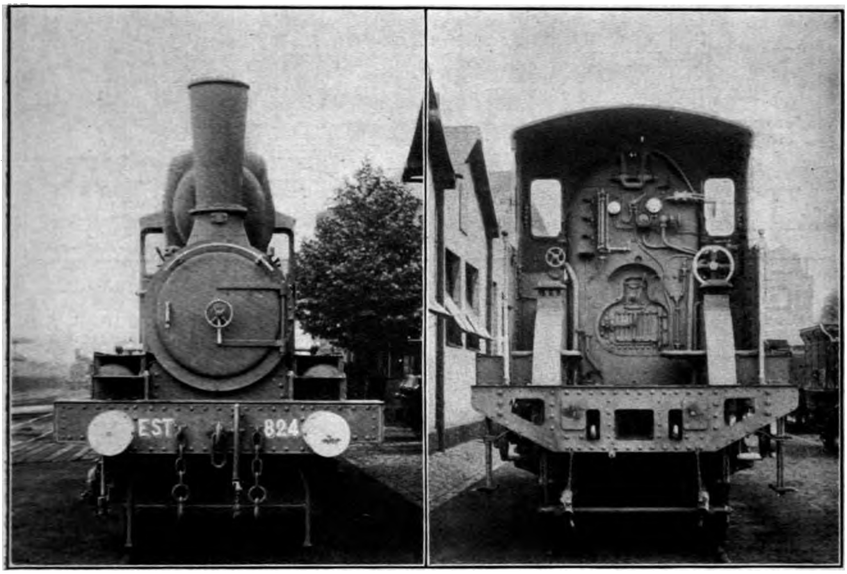
SPECIAL FEATURES IN THE DESIGN OF LOCOMOTIVE BOILERS AND FIREBOXES.

By Chas. S. Lake.

Mr. Lake's preceding papers have dealt with British locomotive practice in its most recent developments. It is of course impossible, within magazine limitations, to do more than touch upon the typical and leading features. The subjects and examples chosen are those which, in Mr. Lake's expert judgment, afford the greatest promise of advance in locomotive engineering practice. In this number he concludes his study by a rapid review of the most important recent work in the United States and on the Continent.—The Editors.

IN 1891 the locomotive superintendent of the Eastern Railway of France, acting in conjunction with M. Flaman, the consulting engineer to that company, carried out some experiments with a boiler of novel construction, invented by the latter gentleman. In order that the idea might be fully tested before laying out a large sum of money on new construction, an old "Crampton" engine already working upon the line was taken into the shops and converted from its original state to that of being provided with the double boiler. The result of this was to elevate what had been previously considered as a machine suitable for dealing with traffic of minor importance only, to that of an engine capable of performing some of the heaviest work upon the system.

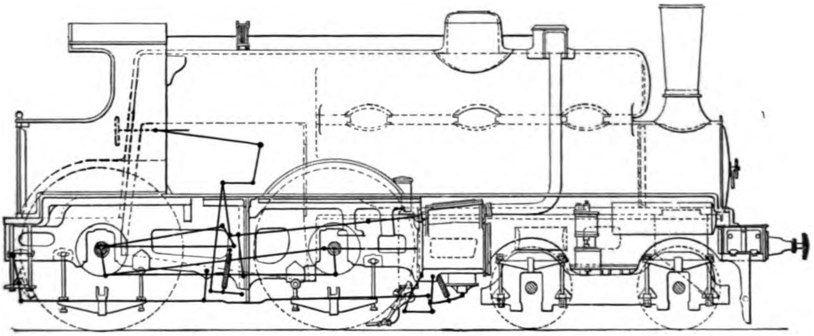
So successful were the results of this metamorphosing process that it was decided to construct some new and powerful locomotives to have the Flaman boiler and firebox, and increased dimensions throughout. The outcome of this decision was that in 1892 a number of two-cylinder engines known as the "800" class were built at the company's works at Epernay, from the joint designs of M. M. Flaman and Salamon, the latter being (both then and now) chief engineer of the traction department of the line.



FRONT AND REAR VIEW, EASTERN OF FRANCE LOCOMOTIVE WITH DOUBLE BOILER.

Since the date of the introduction of the first of the series a large number of these engines have been constructed, and they are divided into two groups numbered 813 to 824 and 825 to 840. M. Salamon has kindly favoured the author with photographs, drawings, etc., of No. 824, one of the first to be built. By referring to these it will be seen that the boiler is composed of two barrels, one superposed upon the other. The lower or main barrel is filled with tubes, whilst the upper barrel or steam drum is devoid of them altogether. The two are connected by means of three connecting saddle pieces at intervals along their length. These are visible only when the engine is not in a complete state, as lagging plates are provided which encase the two chambers and thus hide the saddle pieces from view. The water level is, under normal conditions, just below the centre line of the upper barrel, which is connected at the rear end with the outer firebox casing.

The material employed in the manufacture of the boiler is open-hearth steel. The greatest possible care was taken in its construction, the whole of the plates being carefully reheated and annealed after the operation of flanging had been completed.



EXPRESS LOCOMOTIVE WITH DOUBLE BOILER, EASTERN RAILWAY OF FRANCE.

The boiler has a steam pressure of 170 pounds per square inch, and its total heating surface is 1,770 square feet. The great number of tubes is mainly responsible for this large aggregate. The total capacity of the boiler is 280.45 cubic feet, of which 63.25 feet are steam space.

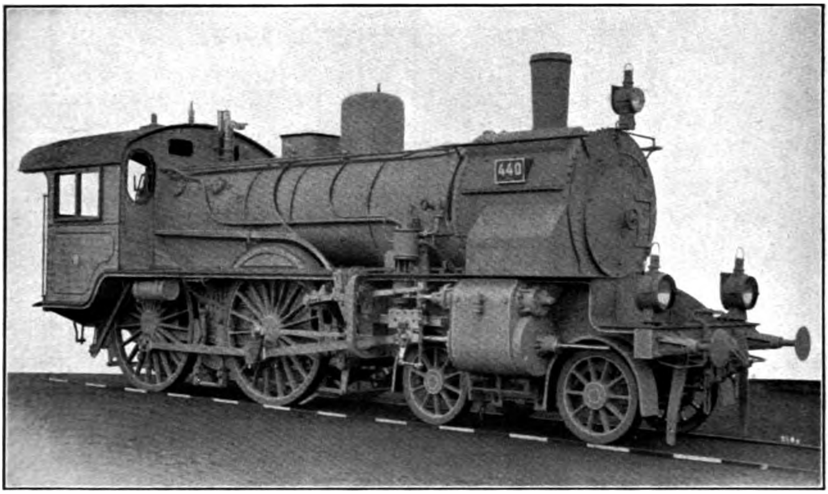
The front plate of the firebox is of wrought iron as are also the steam orifice saddles between the two barrels. The firebox itself is of copper, but the roof is of steel and is corrugated, to reduce the amount of staying required. A water bridge of the Ten Brinck type is fitted inside the furnace, having a heating-surface area of 29.2 square feet. The total heating surface of 1940.8 square feet is made up as follows.

	Sq. feet
Tubes, (steel, 323 in number 1.57 exterior diameter and 14¼ in. in length)	1770
Firebox	146.6
Water bridge	24.2
Total	1940.8

It is claimed that a boiler of this description, deriving, as it does, all its heat in a direct manner from the firebox and the tubes, will utilise a greater proportion of the heat than will the ordinary type of locomotive boiler.

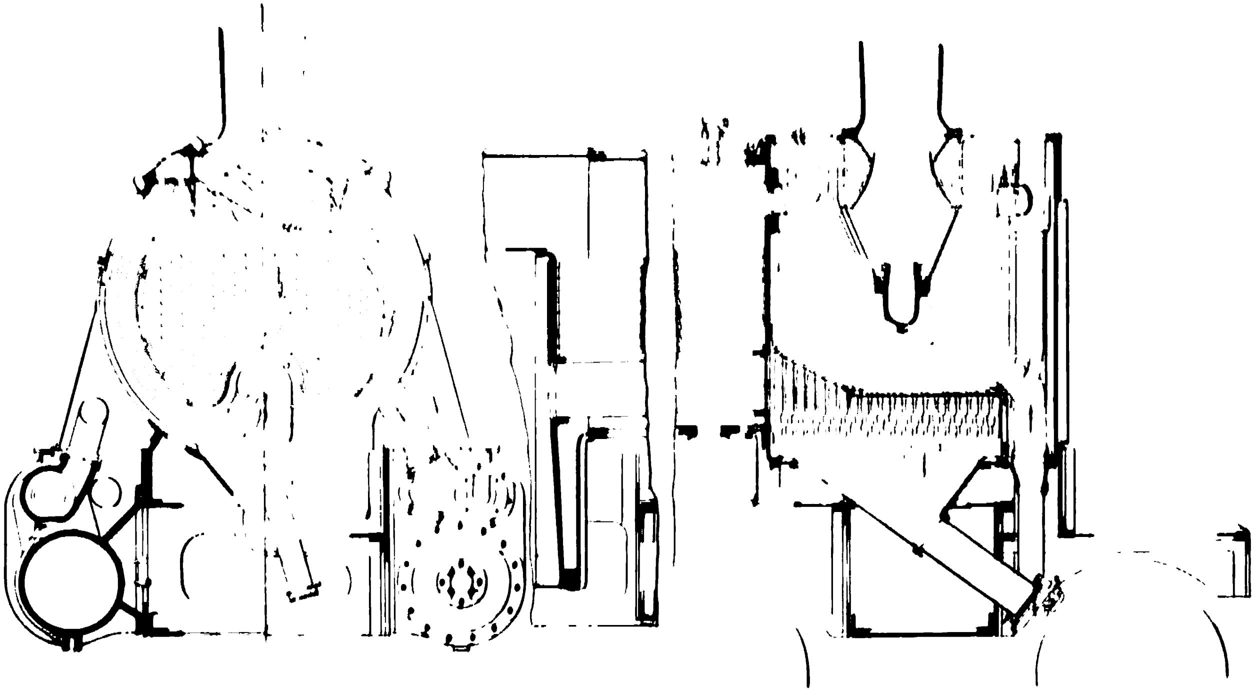
There are a number of locomotives in use upon the Prussian State Railways, both passenger and goods, which are fitted with a very efficient form of superheating apparatus, the invention of Herr Wilhelm Schmidt of Wilhemshöhe near Cassel. These engines were built at the Borsig Locomotive Works, Berlin. The first of the series was exhibited at the Paris Exhibition of 1900, and since then many others have been put into service fitted with the superheater in an improved form. The figure illustrates one of these later engines, No. 440, an express passenger locomotive of an extremely powerful type. The sectional drawings show the general arrangement of the boiler, firebox, and smokebox, in the last-named of which the superheater is situated. This may be briefly described as follows:—

Extending from the firebox to the smokebox, and forming direct communication between the two, a large firetube, usually from 11 to 12 inches in diameter, is fixed. By means of this, the hot gases are conveyed from the furnace to an open space in the smokebox known as the superheating firebox.



BORSIG LOCOMOTIVE WITH SUPERHEATER.

The superheater itself consists of 62 tubes, ranging in size from 1 3/16 to 1 5/16 inches inside diameter, and from 1 1/2 to 1 5/8 inches outside diameter. These tubes are placed about the smokebox in three concentric rings, arranged in groups one behind the other. At their upper extremities they are expanded into a long steam chamber having branches out to right and left. The 21 tubes forming the inner group are arched up at the bottom and pass over the top of the 12-inch flue, clear of the two outer groups, which lie flat along the bottom of the smokebox as will be seen in the cross-sectional



SECTIONAL VIEWS OF SCHMIDT SUPERHEATER, APPLIED TO LOCOMOTIVE BUILT BY BORSIG, OF TEGEL.

views on the facing page. In this manner the open space or superheating firebox, already referred to, is formed, and the gases from the furnace are delivered into it by means of the large firetube.

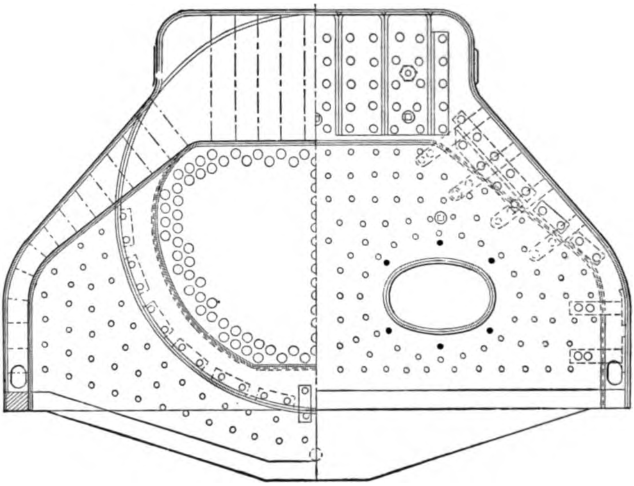
Nearly the whole of the superheater is enclosed in an iron case on either side of the smokebox which can be opened or closed at will by the driver. The distributing steam chamber is at the right-hand side of the smokebox and has a partition in the centre. When the regulator is opened, the damp steam from the dome enters the back division and flows out through the rear to 10 of the three-fold groups of tubes and passes over to the left-hand steam chamber, arriving there in a fairly dry condition as a result of the operations so far carried out.

In this steam box there is no partition, so that the partially superheated steam enters the forward tubes of the three groups and flows back to the right-hand steam box and thence out to the cylinder steam chest. The soot which collects upon the tubes of the superheater can be removed by opening a blower valve, which permits of steam from the dome being discharged through two small apertures against the smokebox wall, at the back of the inner tubes. These jets of steam are directed upwards and downwards and pass between the superheating tubes. A wide-mouth ash pipe is provided for ridding the smokebox of soot and ashes which collect under the superheater tubes, and a second one for the boiler tubes. Herr Borsig states that with the improved pattern of superheater he is able to raise the temperature of the steam, which has a pressure of 170 pounds per square inch, to 575° F. as an average, and 626° F. at a maximum, whilst the coal consumption is reduced by 25 per cent. and water consumption 33 per cent. As the superheater is quite close to the cylinders, the result is that initial condensation is wholly abolished and the entering steam still superheated, so that the usefulness of the appliance is demonstrated beyond any question of doubt.

The total heating surface of the engine illustrated on pages 393 and 394 is 1,452 square feet, of which the superheater is responsible for 322 square feet.

Another example of special construction is to be found in the shape of a stayless boiler, with which some of the Prussian Street Railways locomotives—working in the Cologne district—are fitted. The shell consists of two truncated cones with a cylindrical portion on the middle and an inside corrugated firebox, so arranged that the ends of the boiler are of smaller diameter than the middle section. The top of the boiler is tapered in both directions, the longest slope being towards the smokebox and the greatest steam space being approximately in the middle of the length of the boiler.

The tubes are sufficient to stay the tube plates and no further stays are required. The firebox is divided into two very nearly equal parts by a firebridge of semicircular form. The gases from the fuel are mixed at the firebridge with hot air and are consumed in the combustion chamber beyond.



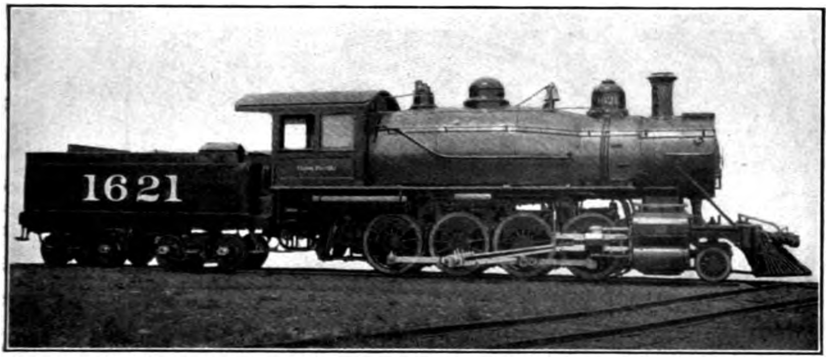
WOOTTEN FIREBOX WITH BELPAIRE STAYING, PENNSYLVANIA ATLANTIC TYPE EXPRESS LOCOMOTIVE.

In the United States there are many and varied forms of locomotive boilers and fireboxes. The American loading gauge, which is of a far more liberal character than that which obtains on the European of the water, is mainly responsible for this. Boilers can be pitched with their axes at a much higher level above the rail there than is possible in any European country and, consequently, larger diameters are allowable and, as naturally follows, wider and deeper fireboxes can be used; therefore it is hardly to be wondered at that in this respect American locomotive engineering is in advance of British practice.

A pattern of firebox known as the "Wootten," or wide type, is largely used in the United States, and is especially applicable to engines of the "Atlantic" type with both pairs of coupled wheels placed in front of the firebox.

Just above is a cross-sectional view of the firebox of one of the Pennsylvania Railroad Company's Atlantic type express engines. This is a Wootten firebox with Belpaire direct staying, and a combustion chamber—which is separated from the inner firebox by a brick bridge-wall—is provided. There are two firedoors, as indeed would seem to be necessary, seeing that the firebox is 8 feet long by 8 feet 6 inches wide, the grate area being no less than 68 square feet. This firebox is adapted for burning anthracite coal of which large quantities are available in the States. The driver's cab in these engines is placed ahead of the firebox over the top of the boiler barrel.

The Vanderbilt boiler is attracting much attention in America. This is another corrugated-firebox arrangement, and is very similar in general design to that upon the Lancashire and Yorkshire Railway already referred to. The cut below shows one of the "consolidation" compound engines built by Messrs. Burnham Williams & Co. of the Baldwin Locomotive Works, Philadelphia, for the Union Pacific R. R. The boiler of this engine is more in accordance with the original design than in some other "Vanderbilt" locomotives. The increased length allowable in the boilers of ten-wheeled engines permits of a first ring of small diameter being used, instead of this ring being tapered down to meet the diameter of the smoke box.

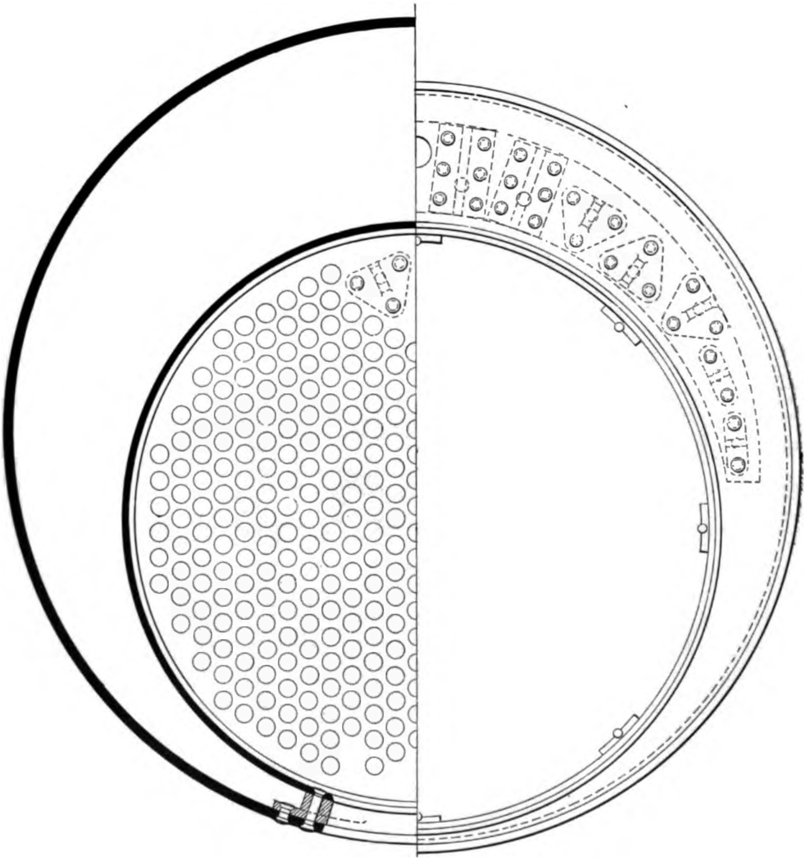


UNION PACIFIC LOCOMOTIVE WITH VANDERBILT CORRUGATED FIREBOX.

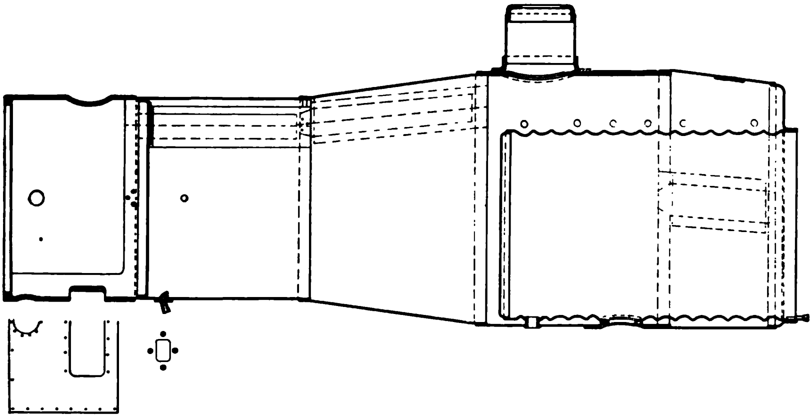
The first Vanderbilt boiler was constructed in 1899, an engine on the New York Central & Hudson River Railroad being fitted with it as an experimental measure. Doubts were freely expressed at the time as to the advisability of introducing corrugated fireboxes into locomotive construction, but in course of time it became evident that no substantial difficulties were incurred by the practice, and the result of this is seen at the present time in the more general adoption of the device.

As has been already remarked, there are many expedients and devices in common use in the United States which are absoluetly precluded from adoption in Great Britain owing to the restrictive character of the limits allowed by the loading gauge and similar considerations. There is a noticeable tendency, however, in Europe, to take advantage of those special characteristics which come within the permissible scope of operations. The Belpaire firebox is becoming quite a common feature of British practice, and is largely used upon the Continent. The advantages claimed are those of direct staying, (both the crown of the firebox and the top of the outer shell having flat surfaces specially adapted for this purpose) and, further, a free circulating area for the water. Longitudinal roof stays are not needed in this pattern of firebox as in those of the ordinary description.

The majority of engineers now provide locomotive boilers with



SECTIONAL VIEW OF BALDWIN LOCOMOTIVE BOILER WITH VANDERBILT CORRUGATED FIREBOX.



LONGITUDINAL SECTION, BALDWIN LOCOMOTIVE BOILER WITH VANDERBILT CORRUGATED FIREBOX.

steam domes—in fact, the practice may be said to be almost universal. Dry steam is a great consideration, and although the provision of a dome does not secure this in anything like a full measure, it goes a long way towards the attainment of the desired object and prevents a great deal of priming. Where boilers are designed to carry very high pressures, such as 200 pounds or more, per square inch, it seems to be advisable to provide four safety valves. A few British engineers are now doing this, as well as those in other countries.

"Serve" tubes, with internal longitudinal ribs, are very prevalent in France and other parts of the Continent. Mr. S. W. Johnson has fitted one of his new compound locomotives with them on the Midland Railway. The net gain in added effective heating surface is said to be considerable. The *nominal* gain is certainly very imposing. In this, as in the majority of other special appliances, a great deal, of course, depends upon circumstances.

In conclusion I desire to tender my thanks to the various locomotive superintendents and others, whose cordial assistance, in the provision of providing photographs, drawings, and particulars, has been of the utmost service in the preparation of this article.

THE COAL-MINING INDUSTRY OF THE UNITED KINGDOM.

By *R. A. S. Redmayne.*

III. THE PRESENT AND THE FUTURE OF BRITISH COAL MINING.

Professor Redmayne's first article, which appeared in our October number, was a historical review of the early period when Great Britain's supremacy in coal mining was undisputed. The second dealt with the era of the increasing use of power-driven machinery, which also was the epoch of the rise of external competition. The concluding article now published treats the subject in its present economic aspects, with particular reference to the very important matter of labour conditions and the future of the industry.—THE EDITORS.

THE question is sometimes asked by the uninitiated, "What is there to learn about coal mining?" It seems to the questioner all that is necessary is to make a hole in the ground and proceed to dig out coal! In reality the science and art of coal mining is one of the fullest applications of all the sciences, and a well equipped modern colliery "presents one of the most remarkable exhibitions of human activity and its triumph over matter." It is a marvel of applied mechanical science, with its great shafts upwards to 20 feet in diameter, its systems of mechanical haulage above and below ground, ventilating fans drawing vast volumes of air often amounting to hundreds of thousands of cubic feet per minute through miles of confined passage, the timbering, mechanical coal cutting, the lighting, and its great winding and pumping engines. To adequately superintend such a colliery, employing, perhaps, 3,000 men and raising a million tons per annum, the mine manager must have considerable knowledge; he must be well grounded in pure science, especially in geology, chemistry, and mechanics, and have had much experience in civil and mechanical, as well as mining, engineering. He must be somewhat of an architect and a good draughtsman, and must be possessed of tact and discrimination—most necessary qualities in one who has to deal with large bodies of men.

Nothing, perhaps, more conclusively demonstrates the great advances that have been made in the management of British collieries and the condition of the employees than what has been done towards the prevention of accidents in the mines during recent years, and the increase in rate of the wages received by the workers.

Taking figures calculated over all the coal mines in the Kingdom, there were in

the year 1851 for each fatal accident 219 persons employed.
" " 1861 " " " " 300 " "
" " 1871 " " " " 345 " "
" " 1881 " " " " 519 " "
" " 1891 " " " " 665 " "
" " 1901 " " " " 733 " "
" " 1902 " " " " 805 " "

On putting it in another way, and taking the year 1900, there was—

for railways, one person killed for every 1,052 employees.
for coal miners, one person killed for every 744 employees.
for seamen in merchant vessels, one person killed for every 133.

At the beginning of the nineteenth century coal miners (coal hewers) received from 2s 3d to 2s 6d per shift of eight to twelve hours; they now receive about 6s for a seven and a half hour shift: that is to say, the coal hewer's wage has, without allowing for increased purchasing power of money, nearly trebled during the last century. Taking underground labour generally, wages are now on an average at least 50 per cent. higher than they were seventy years ago, and the hours worked are quite 20 per cent. less.

It is difficult to make any general statement as to interest on invested capital, but the earnings of the colliery owner have not increased in the same ratio as the rate of wages received by the working miner. Mr. T. H. Elliott, from evidence given before the Royal Commission on Mining Royalties, drew up a report in compliance with the instructions of the President of the Board of Trade, in which he distributed the whole product of the coal trade for the year 1889 thus:—

Wages	55	per cent.
Royalties	8	"
Other charges	25	"
Profit	12	"

According to Mr. J. B. Simpson, a prominent mining engineer and colliery owner in the north of England, the only approximate guidance of much worth in determining the value of the collieries of the kingdom which we can obtain, is from the Inland Revenue returns; but these include the mines of copper, lead and zinc as well. The assessment also includes the rent and royalty. He, however, endeavoured to arrive at an estimate by taking the results given in these returns for thirty years and making a deduction for rents included as estimated by the Royal Commission on Royalties for 1889. The result was 6d per ton profit on all minerals mentioned, but as the greatest proportion of mines were collieries, the figure seems a fair one to take as the average profit on coal for thirty years. If as Mr. Buddle estimated, in the year 1829 it required 8d per ton, to give a 5 per cent. return to the capitalist, the result would be a poor one indeed! In the Report of the Labour Commission of 1893, it was stated that a capital of £100,000,000 was embarked in coal mining in the United Kingdom. 6d per ton profit on an output of 200,000,000 tons of coal gives a return of £5,000,000 per annum. That is to say, sufficient only to give 5 per cent. on the capital invested, and this for all the risks and responsibilities, many of which do not occur in other industries, and from this should be set aside at least 1½ to 2 per cent. to provide a redemption fund to meet the loss of capital which ensues at the end of the lease.

An interesting return was issued in June of this year by the Board of Trade in the form of a Parliamentary paper, "Showing for the United Kingdom and the principal coal-mining districts the quantity and value of coal produced and the number and average wages of coal miners in the years 1901 and 1902 respectively, together with the estimated amounts expended on miners' wages, and remaining for other expenses and coal owners' profits in the United Kingdom for each year."

The manner of arriving at the miners' wages in this return is not accurate; though the amount of error is probably only small, it is still sufficient to influence greatly the amount of profit. In an interesting article in the *Colliery Guardian* for June 19 on the subject of "Coal Owners' Profits," figures are taken out of this Parliamentary Report to show the gross profits earned by capital after payment of all risks:—

	1902.		Average, 1892-1901	
Wages	61,053,000	5s. 4.5d.	49,382,000	4s. 11.5d.
Other expenses	18,924,000	1s. 8d.	16,565,000	1s. 8d.
Profits	13,542,000	1s. 2.3d.	7,105,000	0s. 8.7d.
Total	93,519,000	8s. 2.8d.	73,052,000	7s. 4.2d.

And taking £125,000,000[*] as the amount of capital invested in coal mining in the United Kingdom, there is given a profit over the last ten years of £5. 13. 8. per cent. One hears of the huge profits occasionally made in the coal trade, but little mention is made of the fortunes that have been lost in coal mining. The fact is, that the risks attendant on coal, as in all other mining ventures, are great, and given even a good and well developed colliery, the trade itself is one of the most variable. Taking the Tyneside district this is diagramatically shown over a series of years in Figure 1. Much depends on when a capitalist enters the coal trade and when he leaves it, whether he realises or loses a fortune.

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[*] Which is probably nearer the mark than £100,000,000.

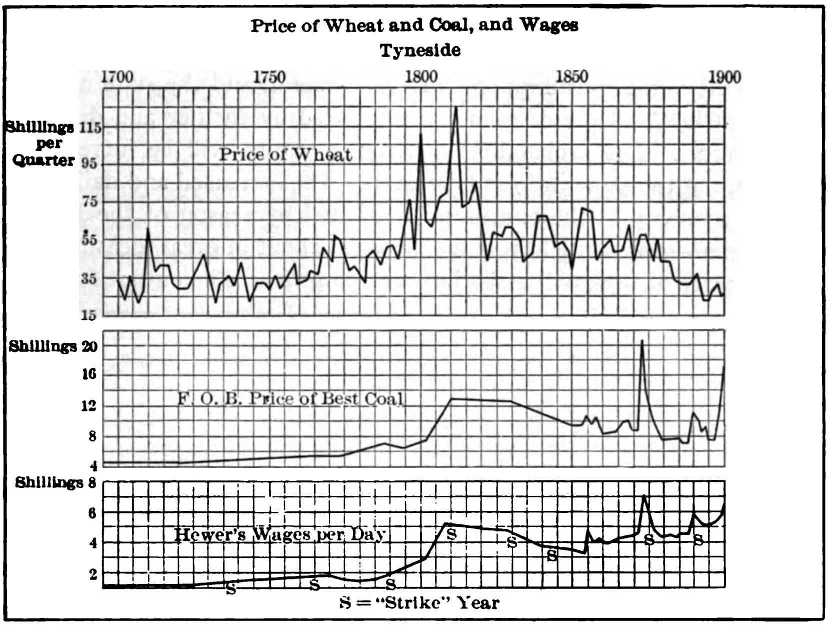

FIG. I. SHOWING VARIATIONS IN THE PRICE OF WHEAT AND COAL, AND RATE OF COAL-HEWER'S WAGES, IN THE NORTH OF ENGLAND (TYNESIDE) BETWEEN THE YEARS 1700 AND 1900.

In considering the present position of the coal-mining industry in Great Britain, two main facts present themselves to the attention of the thoughtful—the approaching exhaustion of the shallower portions of the exposed coalfields, and the growing competition of foreign coal producers.

Professor Hull, at the end of the last century, calculated the area and tonnage yet remaining to work in the visible and concealed coal fields within a depth of 4,000 feet, and excluding seams less than 2 feet in thickness, to be:—

In visible and partly concealed coalfields	58,275,700,000	tons.
In entirely concealed areas	23,253,000,000	"
In Irish coal fields (visible and concealed)..........	155,300,000	"
Total for United Kingdom	81,684,000,000	

or sufficient coal to last, at the present rate of output of, say, 220 million tons per annum, for a period of 371 years.* But some of the exposed coal fields will be exhausted long before this date is reached.

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* Professor Hull puts this period at a little over four hundred years, but he takes as his divisor 200 million tons only.

The question as to whether the present rate of output will be maintained can only be a matter for conjecture, as it is governed by three factors—the home consumption, foreign demand, and the state of the freight market, and these again are controlled by further and diverse circumstances. The probability is that the output will be increased, though not at the same ratio as heretofore. The increased and daily increasing economy in the consumption of fuel by reason of the fuller utilisation of its absolute heat value, brought about in great measure by the high price of fuel, will assist in preventing this. The output for the year 1900 was approximately 225 million tons, for 1901, 219 million tons, and for 1902, 227 million tons, the last figure being the highest in the history of the coal trade of the United Kingdom.

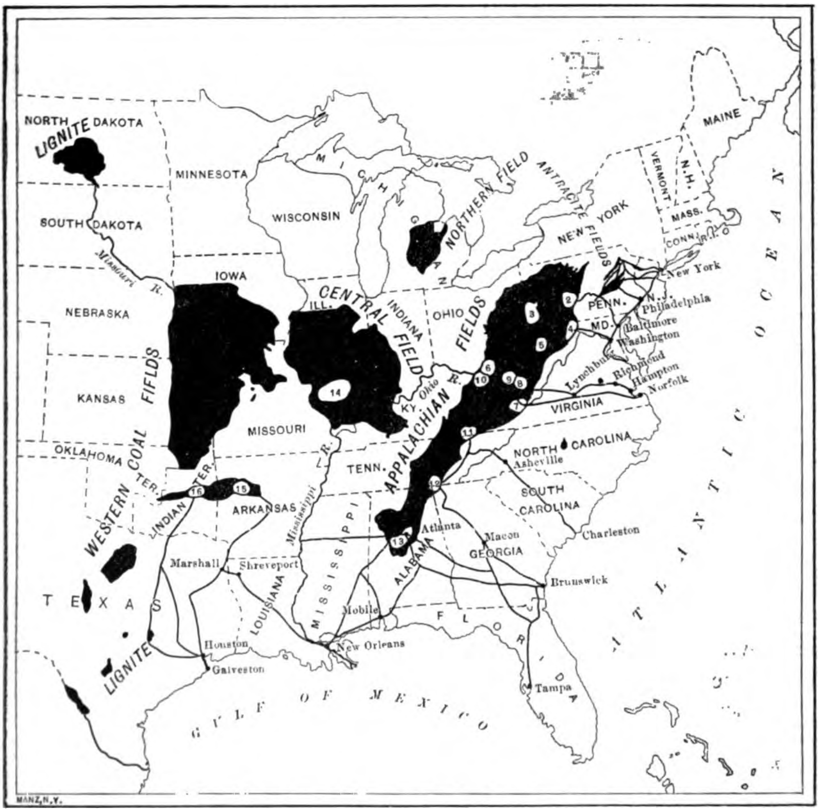

FIG. 2. COALFIELDS AND SHIPPING OUTLETS OF THE UNITED STATES.

The United States of America is Great Britain's most important competitor in point of output, as will be seen from an inspection of the

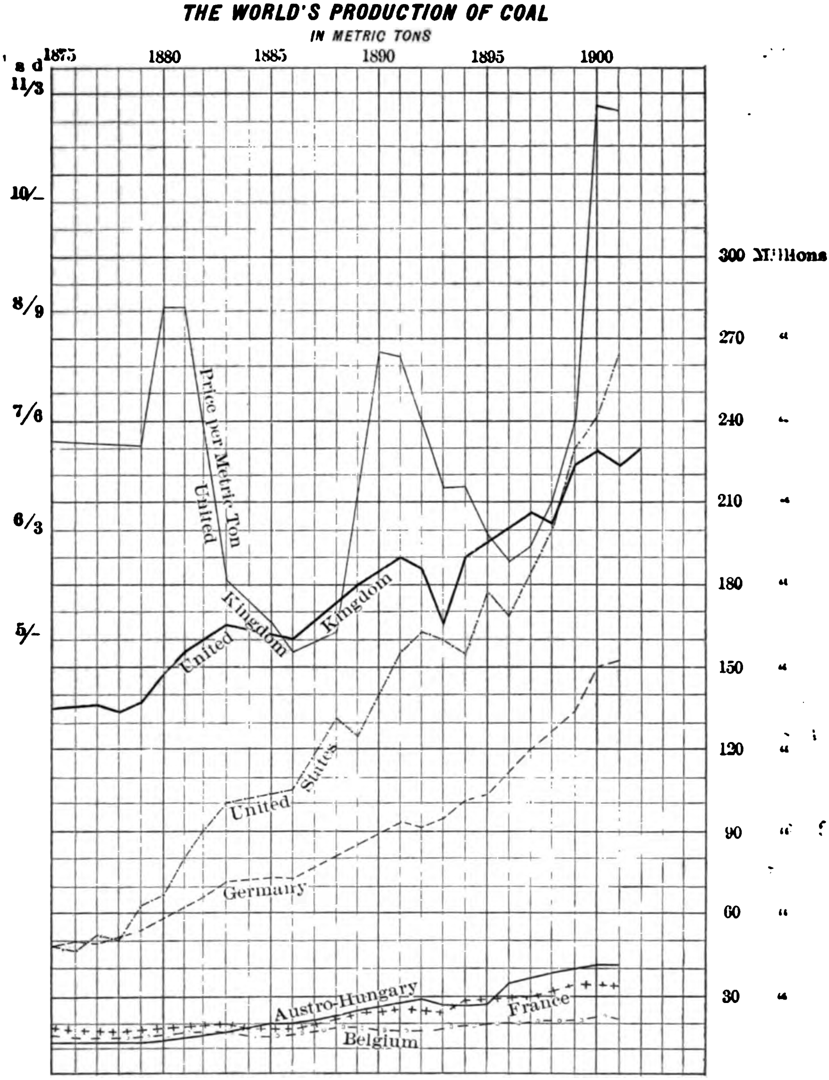

FIG. 4. WORLD'S PRODUCTION OF COAL.

diagrams Figures 3 and 4. Up to 1899 Britain was the largest producer of coal of any country in the world, but in that year the United States took this position from her, with an output of 226,554,000 tons as against 220,094,781 tons, the production of Great Britain. Taking the figures for the commencement of the new century, the world's output was 767,636,204 tons divisible as follows (see Figure 4) :—

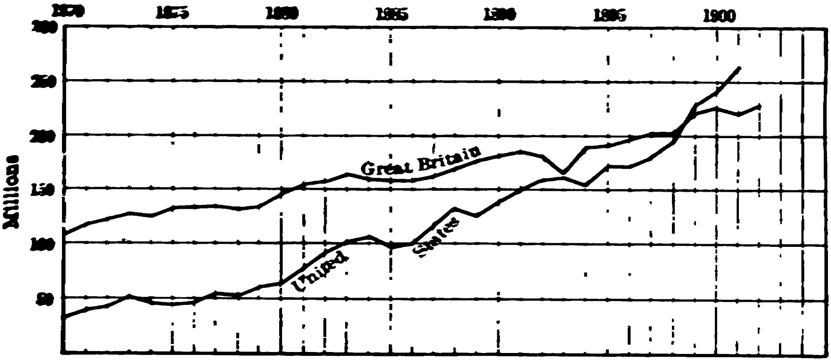

FIG. 3. DIAGRAM SHOWING PRODUCE OF COAL (LONG TONS) IN GREAT BRITAIN AND THE UNITED STATES.

	Millions of tons.		Per cent.	
British Empire { United Kingdom	229	=	30	32.4
British Empire { British possessions	19	=	2.4	
United States of America	245	=		31.9
Rest of the world	274.5	=		35.7
				100.00

It is a noticeable fact that of late years the increased production of coal by the United States has been concurrent with an increasing use of mechanical coal-cutting machinery. Referring back to the time when this kind of machinery was coming into something like general use, about the year 1891, the output in America was 156 million tons, the output for Great Britain being 189 million tons. Comparing these figures with those for 1900, America shows an increase of 89 million tons, against 30 million tons for Great Britain. In the year 1891 there were about fifty firms using in all 550 coal cutters in the United States. In 1900 there were 320 firms using in all 3,900 machines, the coal cut per machine being approximately 10,150 tons in 1891 and 12,050 tons in 1900. But in Great Britain the results shown are very different, there being only 290 machines in use in 1900.*

Nearly 20 per cent. of the total output of America, in fact, is cut by machine; and there are employed in the coal mines some 450,000 as against 760,000 persons in Great Britain.† See Figures 5 and 6.

Germany, also, whose output of coal has doubled within the last ten years, reaching 150 million tons in 1900, is a strenuous competitor.

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* Since the above was written the figures for 1902 are available. There were in that year 166 collieries in the United Kingdom using in all 483 machines which cut 4,161,202 tons of coal, or about 1¾ per cent. of the total output of coal for the year.

† The number of persons employed in British coal mines in 1902 was considerably in excess of the figures given here, viz., 824,791.

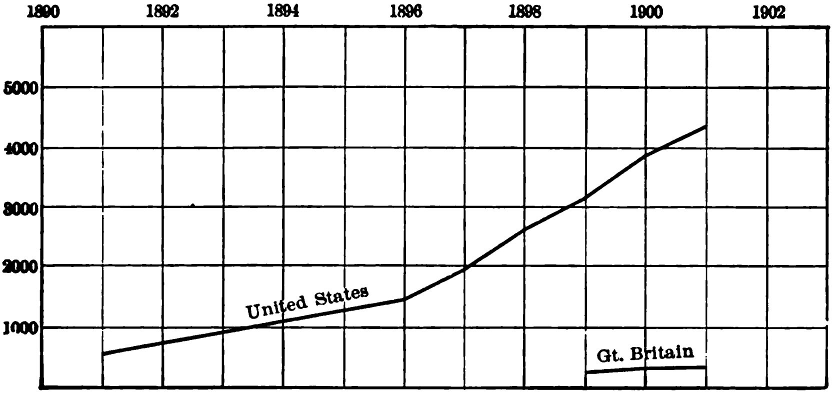

FIG. 5. DIAGRAM SHOWING THE RELATIVE NUMBER OF COAL CUTTERS IN USE IN GREAT BRITAIN AND THE UNITED STATES.

Whereas there is in America a vast quantity of coal near to the surface, which can therefore for many years be cheaply mined, the shallower deposits in Britain are rapidly approaching exhaustion, and the question of deep mining is one of imminent importance.

At the time of the Argyll Commission it was assumed that coal could not be worked, except at a prohibitive cost, at a greater depth than 4,000 feet, owing to the heightened temperature and increased pressure due to depths beyond this limit, and we have seen that the quantity of coal remaining to work at the end of last century within this limit was sufficient to last at present rate of consumption for under 400 years. Yet there are seams of coal lying at much greater depth

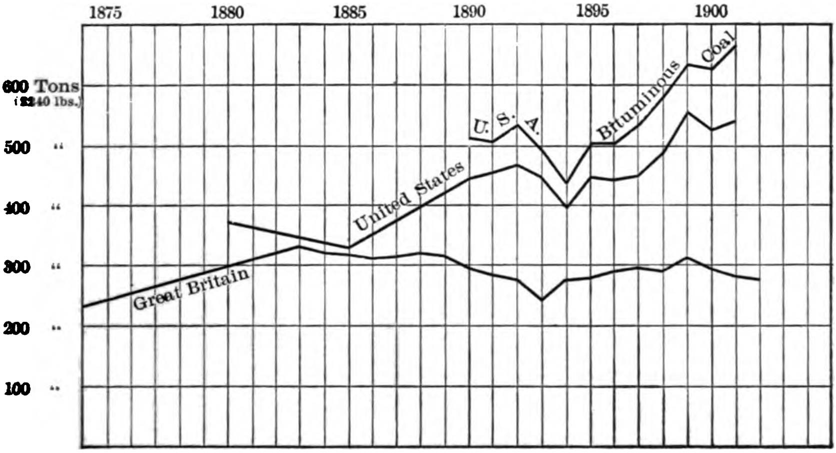

FIG. 6. DIAGRAM SHOWING COAL PRODUCED PER PERSON EMPLOYED PER ANNUM IN GREAT BRITAIN AND THE UNITED STATES.

than this limit in Cheshire, North Staffordshire, Yorkshire, and South Wales, the contents of which should certainly be included in any estimate of the nation's coal supply, at any rate to a limit of 6,000 feet.

Taking the three contentions urged against the feasibility of working coal at great depths in the order here stated, (1) the economic consideration (2) unendurable temperature, and (3) excessive pressure, let us see whether these are likely to act as deterrants to mining down to a 6,000 feet limit.

1.—Economic Considerations. The mechanical difficulties of deep sinkings are not now anything like so great as they were, say fifty years ago, before the era of machine drills of great efficiency, high explosives, and powerful winding machinery. Therefore a modern deep sinking, by reason of improved methods, would be neither so costly nor so slow of accomplishment as a like sinking of fifty years ago.

2.—Increase of temperature. In the report of the last Coal Commission previously alluded to, the conclusion is arrived at that at a depth of 3,000 feet, the temperature of the earth would amount to 98° F, but it was thought that a depth of at least 4,000 feet might ultimately be reached in coal mining. (Report Vol. 1, p. 88) The rate of increase the commissioners thought might, for ordinary cases, be assumed to be 1° Fahr. for every 60 feet; but it is in reality impossible to give any fixed rate of increase. The Report of the British Association Committee on Underground Temperatures, during the last thirty years, tends to show, not only that the temperature gradient varies considerably in different localities, but that it is not easy to deduce a fixed law of increase applicable to all cases. In some parts of western America the heat at 3,000 feet is almost unbearable, while at the Calumet and Hecla Copper Mine in northern Michigan, U. S. A., there is a rise of only 4° Fahr. in a depth of 4,400 feet, although no artificial ventilation is resorted to. The temperature of the coal on discovery at the Rosebridge Colliery in Lancashire, was stated by the management to be 93° Fahr., but it afterwards fell to 63° Fahr.

3.—It does not appear that the question of pressure need be regarded as a bar to working our deeper coal seams, seeing that, certainly up to 7,000 feet—beyond which limit it is doubtful if there be much coal in the British Isles—it would not act as a preventive.

To sum up the situation. It appears that there is coal in the United Kingdom to a depth of 4,000 feet, sufficient at about the present rate of output to suffice for 371 years, but that this period will be considerably extended seeing that there is every probability that mining can be carried on to a depth of 7,000 feet, though at this depth there will not

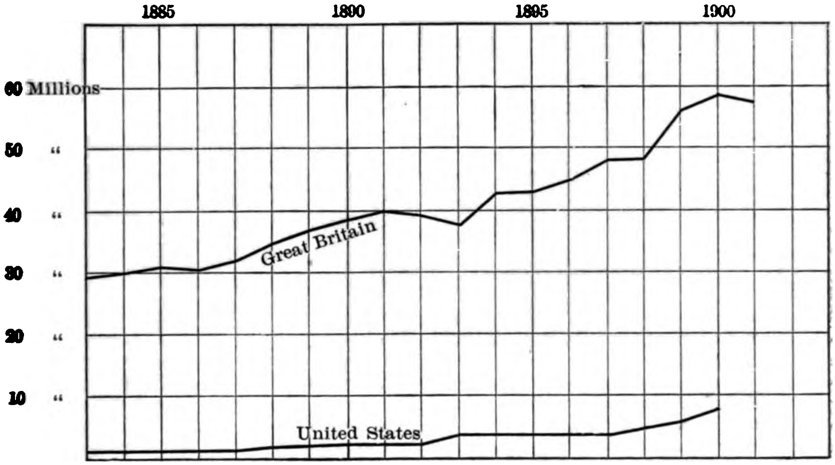

FIG. 7. QUANTITY OF COAL EXPORTED FROM GREAT BRITAIN AND THE UNITED STATES.

be anything like the area of coal that there is at the former limit. And it further seems reasonable to expect that this period of supply may be still further extended by the more economical use of fuel, due to the establishment of central electrical supply stations, and the utilisation of Mond and other gas-producing processes, and of gas-driven engines, as well as other means of obtaining a higher percentage of the heat value of the fuel. Professor Jevons maintains "it is wholly a confusion of ideas to suppose that the economical use of fuel is equivalent to a diminished consumption. The very contrary is the truth," but in this he is not quite correct. To take but one instance. In all well managed collieries there is a constant effort to keep down the percentage of coal that goes to "colliery consumption." Any saving effected does not go towards further development, but to profit. Speaking generally, economy does lead to increased consumption, but not to the extent of the economy effected.

Turning to foreign competition; this must necessarily for some time be an increasing factor, owing to the great developments that have been made and are taking place in the coal-mining districts on the Continent and in America. In order to compete successfully with our rivals for the trade, we must fight them with their own weapons; some of them can be enumerated:—The more perfect screening and cleaning of our coal, the introduction of labour-saving appliances to the greatest possible extent, such as coal-cutting machinery—in fact the elimination, as far as is possible, of the human factor in mining and preparing the coal for the market, and the higher training of our mining engineers.

THE SYSTEMATIZED OPERATION OF ISOLATED PLANTS.

By Percival Robert Moses.

Mr. Moses' opening words well indicate the interest of his theme. With the extension of the use of electricity and the increase in the size of individual buildings, the isolated plant is following the course of all modern business and reaching the stage where system and organization must take the place of individual management—or at least, of the hand and eye of the individual manager. And it is hardly necessary to point out that the electric plant of the modern large alartment quite equals, in both size and diversity of duty, many a public central station which but a few years ago would have been thought of very fair size. The methods advanced by Mr. Moses, therefore, have even a more general application than the title suggests.—The Editors.

THE systematic operation of steam and electric plants for private purposes is becoming of greater importance as the size and number of these plants increases. Formerly when buildings were five-stories high and scattered over large areas, isolated private power plants were few and of small size. Under present conditions, with buildings covering an acre or more of ground and rising twenty or thirty stories in the air, the problem has become different and vastly more important. It is no longer sufficient, nor is it safe, for an owner of a large building to let things run themselves, contenting himself with looking at the bills at the end of the month. With a competent operating engineer he can do it, but it will be expensive in nine cases out of ten; and with an incompetent man frightful accidents are possible and the plant is sure to run down.

A power plant of a modern high building may contain boilers, engines, dynamos, switchboard, pumps, refrigerating and ice-making machinery, elevators, steam-heating, electric-lighting, and plumbing appliances, and other apparatus. All this must be taken care of and watched. Systematizing the operation covers the employment and regulation of the engineer and his staff; the recording and tabulation of the work done by the plant, of the conditions under which this work is done, and of the material and labor required to produce it; the purchase of supplies and the comparison of their values, and periodical inspection.

Small plants with a single boiler and engine, as well as large plants containing thousands of horse power of machinery, are the better for such a system. With the small plant the economy is often greater proportionately than with the large one, as in the larger plant a higher class of intelligence is obtainable. In all cases the amount of red tape and records should be reduced as low as consistent with a complete knowledge of the operation cost, as too much information may result in no attention being paid to the records.

In the employment of engineers and their assistants, application blanks are great time savers and a convenient means of filing applications. This blank is to be filled out by the applicant in his own handwriting, and not only are the age, nationality, and references, etc., shown, but the neatness, education, and sometimes sobriety of the applicant may be judged. The references given on the blank should be looked up, the people seen if possible, and the results endorsed on the application. Written references are of little value, as the most useless engineers often have first-class letters and license. When the choice is made, some form of written agreement should be signed, covering the hours, amount of pay, duties, overtime work, reasons for summary discharge, notice of intention to leave, and termination of pay in event of summary discharge for cause; with the chief engineer, further details as to staff allowed, purchase of supplies, commissions, etc., may be added if desired; the object is to have a full and complete understanding before hand.

The duties of a chief engineer in a large plant are wholly executive; that is, he is the director, and his work should be confined to directing and overseeing the work of his subordinates; he should be held responsible for the fulfilment of rules, correctness of records, discipline of the force. and condition of the machinery. Hence the force under him should be subject to his orders only and be approved of by him. The chief engineer should have nothing whatever to do with the purchase of supplies, except to test and report on their value, to make out or approve requisitions, to check receipts, and to note quantity of material on hand. He should make a daily summary of the plant operation, and render a monthly and annual report as hereafter indicated. While the engineer should not as a rule do any adjustment or manual work around the plant, he should be a practical man able to do the work when necessary, and capable of teaching his men by personal example. If he studies and is technically educated, so much the better.

The chief engineer of a small plant, less than 500 horse power, must necessarily be a working engineer. His duties are similar to those of an assistant on a large plant—i. e., adjusting working parts, making

APARTMENT HOUSE

DAILY POWER LOG

DATE, ____________________

	AMPERES									VOLTS		STEAM		TEMPERATURES						REF. PLANT PRESSURES						
TIME	NO.1	NO.2 A	NO.2 B	NO.3 A	NO.3 B	NO.4	NO.5		TOTAL	A	B	HIGH	BACK	BRINE INLET	O'LET	WATER INLET	O'LET	ICE TANK	FEED WATER	GEN.	ABS.	BRINE	WATER	ST'M GEN.		NOTES AND REMARKS
7A.M.																										
8A.M.																										
9A.M.																										
10AM.																										
11AM.																										
12N.																										
1P.M.																										
2P.M.																										
3P.M.																										
4P.M.																										
5P.M.																										
6P.M.																										
7P.M.																										
8P.M.																										
9P.M.																										
10PM.																										
11PM.																										
12M.																										
1A.M.																										
2A.M.																										
3A.M.																										
4A.M.																										
5A.M.																										
6A.M.																										
TOTAL																										

TIME SHEET

EMPLOYEES	ARR.	LV.	EMPLOYEES	ARR.	LV.	MACHINES	START	STOP	MACHINES	START	STOP	NOTES
CHIEF ENG.			COAL PASSER 1			BOILER 1			ICE MACH.			KIND OF DAY
1ST ASST."			" " 2			" 2			GEN.NO.1			CANS OF ASHES
2ND " "			" " 3			" 3			GEN.NO.2			QUALITY OF COAL
3RD " "			" " 4			" 4						QUANTITY OF COAL ON HAND
4TH " "									BRINE PUMP 1			TEMPERATURE 7 A.M.
			OILER NO.1			ENGINE 1			" " 2			
FIREMAN 1			" " 2			" 2						
" 2			" " 3			" 3			VOLT PUMP 1			
" 3						" 4			" " 2			
" 4						" 5						
" 5			ELECTRICIAN 1									
			" 2			ELEV.PUMP 1						
1ST ICE MAC.						" " 2						
2ND ICE MAC.			PLUMBER NO.1									
MACHINIST			" " 2									
LABORER 1												
" 2			OTHERS									
" 3												

repairs, taking records, directing firemen and oilers, with the added duty of the daily, monthly, and yearly summary. This work demands a man with more ability than an assistant on a large power plant, as he is more his own master and has to meet questions of greater variety.

The other members of the staff have special duties to perform, and their knowledge of these specialties is the measure of their value. Honesty, common sense, ambition, and sobriety are the real essentials; the other qualities and accomplishments can be developed.

Subdivision of the work to be done is important, as in this way only can time be employed advantageously, men used for the work for which they are best fitted, and most important of all, responsibility fixed for omissions or faults. There are certain duties to perform at stated intervals—e. g., elevator machinery must be inspected, oiled, and cared for daily; boilers must be blown down and their safety valves tried; engines must be indicated, gauges tested, etc. If it is not done there is someone to be held accountable. Of course, all this is subject to variation when contingencies arise; when they do, the man detailed must report his inability so that the work can be handled. It is a good plan to have each man thus detailed provided with a book in which the work done and the time required may be briefly noted. At the end of the day the books are turned in to the chief. The general operation of the plant is recorded by hourly reading of the wattmeters, ammeters, voltmeters, steam, ammonia, and water gauges, thermometers, and water meters.

These record sheets are the foundation of system in operation; they are greatly lessened in value unless filled out with care, and studied. Their value for cost determination has been treated in a previous paper* on "Cost Determination in Isolated Plants," but their bearing on the operation and on the employees deserves notice. A poor engineer —a lazy, uneducated, or unambitious man—will not bother with them; the other type—the ambitious, studious, and working engineer—will not only fill out the blanks as indicated, but take pains to get more information and to put it on record. Some of the blanks used in what is said to be the largest apartment house in the world are shown on pages 414-416. This building covers a plot 200 feet square, and rises seventeen stories above the curb, with two stories below. It contains 1,400 horse power of boilers, 1,600 horse power of compound high-speed engines directly connected to 1,000 kilowatts of dynamos, triple and compound elevator pumps, hot, cool, and iced-water systems, ven-

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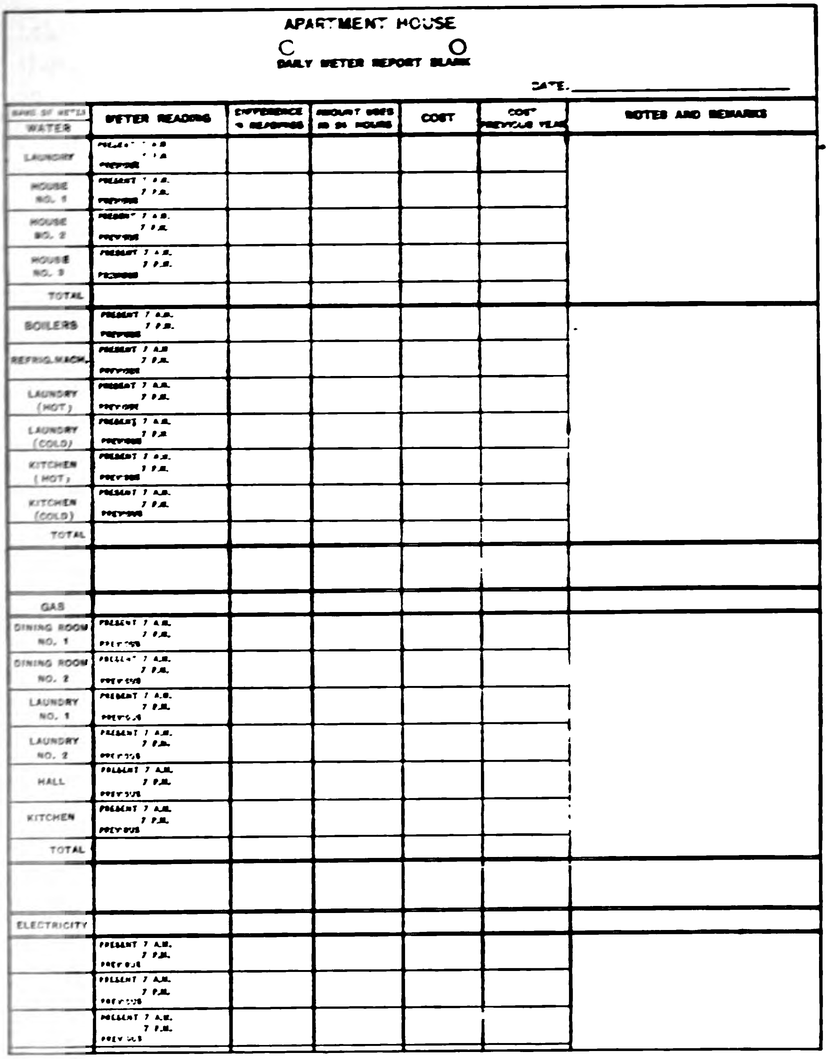
* Cost Determination in Isolated Plants; Percival Robert Moses, THE ENGINEERING MAGAZINE, March, 1901, p. 1082 *et seq.*



APARTMENT HOUSE

DAILY METER REPORT BLANK

DATE. ____________________

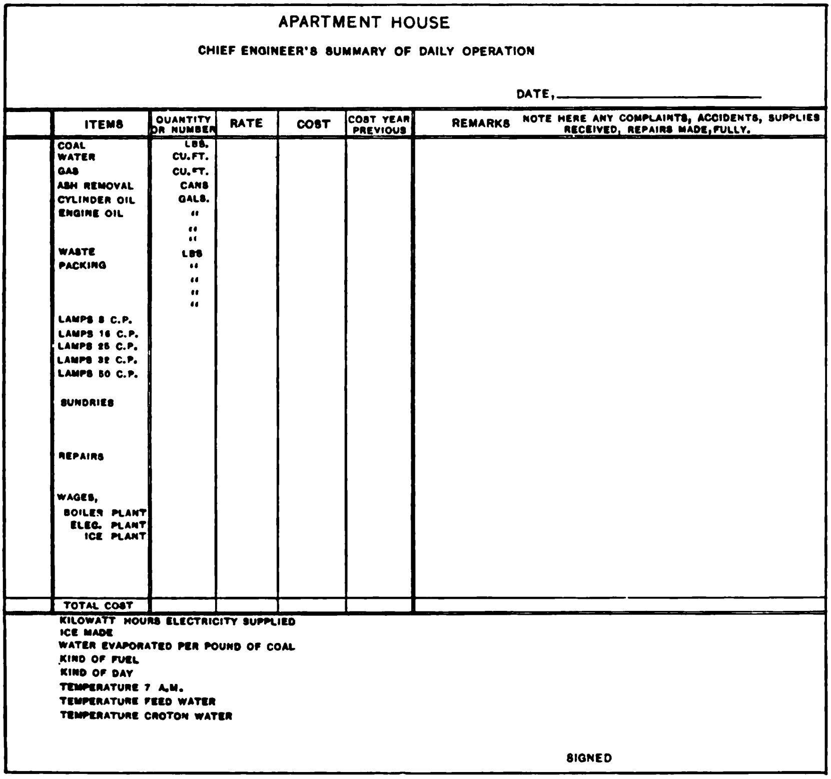
NAME OF METER	METER READING	DIFFERENCE IN READINGS	AMOUNT USED IN 24 HOURS	COST	COST PREVIOUS YEAR	NOTES AND REMARKS
WATER						
LAUNDRY	PRESENT 7 A.M. 7 P.M. PREVIOUS					
HOUSE NO. 1	PRESENT 7 A.M. 7 P.M. PREVIOUS					
HOUSE NO. 2	PRESENT 7 A.M. 7 P.M. PREVIOUS					
HOUSE NO. 3	PRESENT 7 A.M. 7 P.M. PREVIOUS					
TOTAL						
BOILERS	PRESENT 7 A.M. 7 P.M. PREVIOUS					
REFRIG. MACH.	PRESENT 7 A.M. 7 P.M. PREVIOUS					
LAUNDRY (HOT)	PRESENT 7 A.M. 7 P.M. PREVIOUS					
LAUNDRY (COLD)	PRESENT 7 A.M. 7 P.M. PREVIOUS					
KITCHEN (HOT)	PRESENT 7 A.M. 7 P.M. PREVIOUS					
KITCHEN (COLD)	PRESENT 7 A.M. 7 P.M. PREVIOUS					
TOTAL						
GAS						
DINING ROOM NO. 1	PRESENT 7 A.M. 7 P.M. PREVIOUS					
DINING ROOM NO. 2	PRESENT 7 A.M. 7 P.M. PREVIOUS					
LAUNDRY NO. 1	PRESENT 7 A.M. 7 P.M. PREVIOUS					
LAUNDRY NO. 2	PRESENT 7 A.M. 7 P.M. PREVIOUS					
HALL	PRESENT 7 A.M. 7 P.M. PREVIOUS					
KITCHEN	PRESENT 7 A.M. 7 P.M. PREVIOUS					
TOTAL						
ELECTRICITY						
	PRESENT 7 A.M. 7 P.M. PREVIOUS					
	PRESENT 7 A.M. 7 P.M. PREVIOUS					
	PRESENT 7 A.M. 7 P.M. PREVIOUS					

DAILY METER REPORT BLANK FOR APARTMENT HOUSE PLANT.

17 inches high by 13 inches wide. Perforated at the top for binding.

tilating, heating, and refrigerating apparatus, and pumps of various kinds. Electricity is supplied for lighting and for motors driving laundry and ventilating appliances. Brine is pumped through coils in refrigerators, located in various apartments, cooling these, and allowing ice to be made in shallow pans by the tenants. About 5 tons of ice a day is made in the ice-making tank for restaurant and kitchen use.

An example of the interest intelligent engineers take in such records is shown in this plant, as the day and night engineer vie with each other as to who can turn out the most complete records, and the chief engineer spends hours of his spare time studying and tabulating the results. The first or basic blank is the watch report made by the engineer on duty, and shows the hourly condition of the plant, through record of amperes delivered by each dynamo; and in the case of 3-wire balance-coil dynamos, of each side of circuit, voltage on each side of system; high and low steam, ammonia, and brine pressures; brine, ice, and feed-water temperatures. The men on duty and the machines in operation are also noted, and any repairs done. The meter blanks filled out once or twice daily show the quantities of water, gas, and electricity consumed in different departments, and the daily summary



APARTMENT HOUSE

CHIEF ENGINEER'S SUMMARY OF DAILY OPERATION

DATE, ____________

	ITEMS	QUANTITY OR NUMBER	RATE	COST	COST YEAR PREVIOUS	REMARKS NOTE HERE ANY COMPLAINTS, ACCIDENTS, SUPPLIES RECEIVED, REPAIRS MADE, FULLY.
	COAL	LBS.				
	WATER	CU. FT.				
	GAS	CU. FT.				
	ASH REMOVAL	CANS				
	CYLINDER OIL	GALS.				
	ENGINE OIL	"				
		"				
		"				
	WASTE	LBS				
	PACKING	"				
		"				
		"				
		"				
	LAMPS 8 C.P.					
	LAMPS 16 C.P.					
	LAMPS 25 C.P.					
	LAMPS 32 C.P.					
	LAMPS 50 C.P.					
	SUNDRIES					
	REPAIRS					
	WAGES,					
	BOILER PLANT					
	ELEC. PLANT					
	ICE PLANT					
	TOTAL COST					

KILOWATT HOURS ELECTRICITY SUPPLIED
ICE MADE
WATER EVAPORATED PER POUND OF COAL
KIND OF FUEL
KIND OF DAY
TEMPERATURE 7 A.M.
TEMPERATURE FEED WATER
TEMPERATURE CROTON WATER

SIGNED

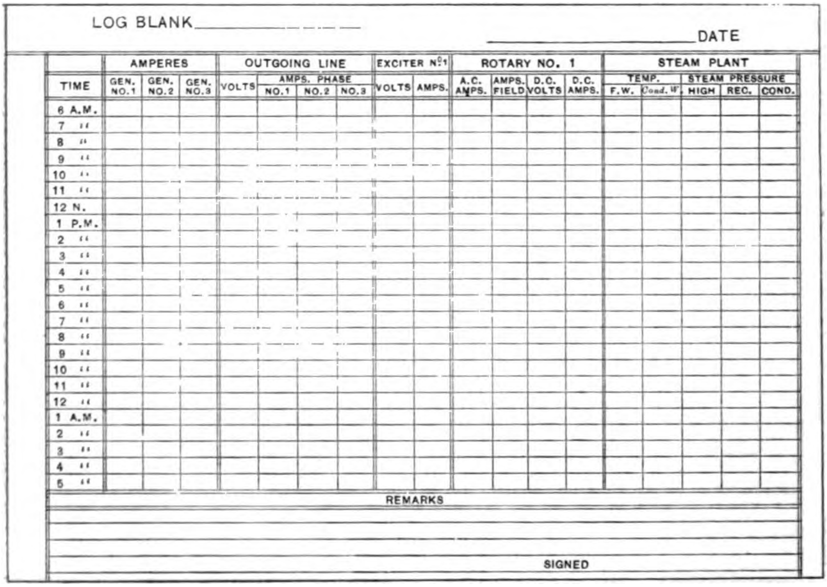
FORM FOR CHIEF ENGINEER'S SUMMARY, APARTMENT HOUSE POWER PLANT.

13½ inches wide by 17 inches high. Bound in books by perforated right hand margin. The original allows greater proportionate space at the bottom for notes or remarks.

shows the cost of each factor for the day, the cost for the same day of the previous year, the quantities of electricity and ice made.

Another set of record blanks is shown for a power plant supplying electricity to motors, etc., for irrigation and sugar manufacture. The main features are the same as those of the apartment-house blanks—that is, one blank contains the hourly records of electricity, steam, and temperatures, and the time sheet of men and machinery; the second blank shows total power supplied for irrigation, power for mill and light; also amount of coal, labor, oil, etc., required; the cost of each item and the total cost; supplies received and required, and such notes as the chief engineer wishes to record. Other blanks are used for repair, or new work, showing quantity and cost of labor and material used. The records are forwarded to the New York office, and curves made showing at a glance variation in cost per unit of power, etc. This plant has been in operation about a year, and the records are not only instructive as to design of future plants, but also point the way to economize in present operation.

The value of the hourly report lies not only in the data made available, but in the frequent inspection of the different pieces of apparatus



LOG BLANK ____________

____________ DATE

	AMPERES			OUTGOING LINE				EXCITER No. 1		ROTARY NO. 1				STEAM PLANT				
TIME	GEN. NO. 1	GEN. NO. 2	GEN. NO. 3	VOLTS	AMPS. PHASE			VOLTS	AMPS.	A.C. AMPS.	AMPS. FIELD	D.C. VOLTS	D.C. AMPS.	TEMP.		STEAM PRESSURE		
					NO. 1	NO. 2	NO. 3							F.W.	Cond. W.	HIGH	REC.	COND.
6 A.M.																		
7 "																		
8 "																		
9 "																		
10 "																		
11 "																		
12 N.																		
1 P.M.																		
2 "																		
3 "																		
4 "																		
5 "																		
6 "																		
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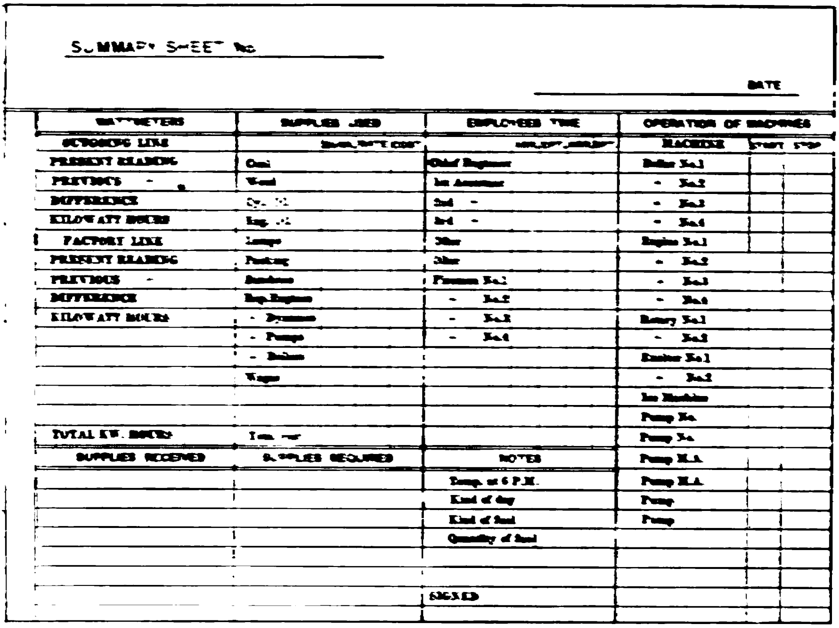
11 "																		
12 "																		
1 A.M.																		
2 "																		
3 "																		
4 "																		
5 "																		

REMARKS

SIGNED

WATCH REPORT (OR LOG BLANK) OF A CENTRAL STATION SUPPLYING POWER FOR SUGAR MANUFACTURE AND IRRIGATION.

Filled out by the engineer on duty. Actual size 12¾ inches wide by 11¼ inches high. Extra columns are provided for additional rotaries and exciters.



SUMMARY SHEET No.

DATE

WATTMETERS	SUPPLIES USED	EMPLOYEES TIME	OPERATION OF MACHINES		
OUTGOING LINE	[illegible] COST	[illegible]	MACHINE	START	STOP
PRESENT READING	Coal	Chief Engineer	Boiler No. 1		
PREVIOUS "	Wood	1st Assistant	" No. 2		
DIFFERENCE	Cyl. Oil	2nd "	" No. 3		
KILOWATT HOURS	Eng. Oil	3rd "	" No. 4		
FACTORY LINE	Lamps	Oiler	Engine No. 1		
PRESENT READING	Packing	Oiler	" No. 2		
PREVIOUS "	Sundries	Fireman No. 1	" No. 3		
DIFFERENCE	Rep. Engines	" No. 2	" No. 4		
KILOWATT HOURS	" Dynamos	" No. 3	Rotary No. 1		
	" Pumps	" No. 4	" No. 2		
	" Boilers		Exciter No. 1		
	Wages		" No. 2		
			Ice Machine		
			Pump No.		
TOTAL KW. HOURS	Total cost		Pump No.		
SUPPLIES RECEIVED	SUPPLIES REQUIRED	NOTES	Pump H.A.		
		Temp. at 6 P.M.	Pump H.A.		
		Kind of day	Pump		
		Kind of fuel	Pump		
		Quantity of fuel			
		SIGNED			

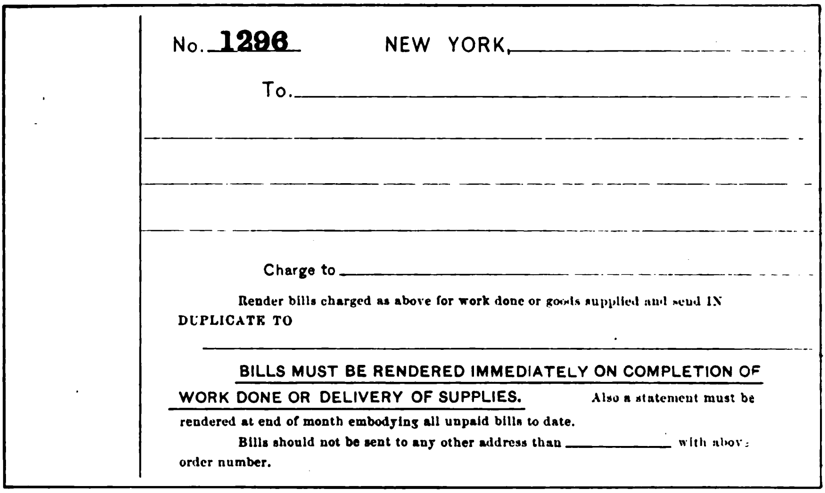
SUMMARY SHEET, SUGAR FACTORY CENTRAL STATION.

Actual size, 12¾ wide by 11¾ inches high.

and the continual observance of conditions by the men on watch, who otherwise might not notice any trouble until an accident had occurred; besides, the men learn to know better the meaning of the different readings, their relation to each other and to the cost of operation. They learn that it does cost more to supply 50 killowatt hours than 40, and they can know, if they take the trouble to find out, how much more it will cost. In a phrase, it substitutes definite knowledge for indefinite opinions. The daily summary puts in a concise form for record and reference the important parts of the daily log, and is essentially a cost sheet showing the cost of manufacture for the day, and the quantity and value of the product turned out. The monthly and yearly summaries are reports based on the daily summaries and no special blank is necessary. A useful adjunct to the daily log is a curve sheet on which is shown graphically the hourly variation of electricity supplied, coal used, cost, etc. Where electricity is sold, a meter report blank showing fac-simile of meter dials is convenient.

In the purchase and checking of supplies, it is advisable that the requisition shall be made up or approved by the head of the department for which they are needed, and that the orders shall be numbered and be in triplicate, one to be held at the purchasing office, and the others sent to the seller and the receiving department. On receipt of materials, the order must be checked and returned to purchasing department. To avoid unnecessary clerical work, the orders may be made up in book form, pages being differently colored, three pages numbered alike and the second and third perforated for tearing out. An order blank of this character is shown on this page.

Requisitions for material should be in duplicate and of different colors. The order blank should contain the date of requisition, date of order, and space for noting date of receipt of the material, also directions for shipping and charging and the signature of the purchaser. Where the quantity of supplies to be purchased warrants, the chief engineer should present about the middle of each month a complete list of probable needs for the following month, thus allowing ample time for obtaining competitive bids and getting delivery.



No. 1296 NEW YORK, ____________

To. ____________

Charge to ____________

Render bills charged as above for work done or goods supplied and send IN DUPLICATE TO

____

BILLS MUST BE RENDERED IMMEDIATELY ON COMPLETION OF WORK DONE OR DELIVERY OF SUPPLIES. Also a statement must be rendered at end of month embodying all unpaid bills to date.

Bills should not be sent to any other address than ____________ with above order number.

ORDER BLANK FOR PURCHASE OF SUPPLIES.

Made out in triplicate, one each for purchasing office, receiving department, and seller; original, duplicate, and triplicate are of different colors. Actual size, 5¼ inches wide by 5½ inches high; thin paper.

The comparison of results is the most difficult and important part of the operation of a plant. Unless the size of the plant is sufficient to permit installation of a scale for coal, photometer for lamps, wattmeters for power, and water meters for water, intelligent and accurate comparison is not possible. A close approximation can be reached by crude devices such as a bin for measuring coal and hourly ammeter and voltmeter readings, and these must suffice where there is nothing better. The aim of the whole system is to produce results at the least cost consistent with continuous and reliable operation; hence to keep abreast with the state of the art, experiments should be tried where improvements seem possible, and the results carefully noted.

The system of record blanks outlined offers a ready means of noting and comparing results, as the plant is going through a complete test under working conditions every day—a test of greater value than the ordinary test for acceptance or rejection.

The most important items of cost in an isolated plant are usually labor, fuel, and repairs. The comparison of labor cost by the daily summary is self evident. The relative cost of different fuels for a given plant can be accurately determined only where the water evaporated can be measured both as to quantity and temperature, the fuel weighed, and the quantity of waste or ash noted; the latter has a bearing only where its removal costs or where the labor is increased. The cost of repairing and maintaining machinery can be judged only through long experience combined with a complete record of costs.

The system of operation briefly outlined and the blanks shown are the result of practical experience with the slip-shod hit or miss methods in vogue in most plants of moderate size. Frequently the operating engineers oppose the introduction of system in every way possible, as it entails a little more labor and tends to prevent "grafting" and favoritism.

The amount of time required to record the meter readings is not over five minutes in the most extensive plant, unless the gauges are widely scattered; and the preparation of the summary, if the daily logs are properly filled out, is a matter of barely half an hour.

EDITORIAL COMMENT

THE triumph of the Panama Canal project—the fulfilment of the measures which will assure its undertaking and its building—at this writing seems within short and quite definite reach. This (to many unexpected) ending of the long struggle affords one of the most brilliant examples in modern times of the unquenchable vitality of economic truth. The phenomenon indeed is world-old. In one form or another it has attended almost every step in the development of material civilization. The thing which makes for economy, which gives a larger profit return for the unit of energy expended, *will* get itself into being. Nature seems utterly lavish of life and force, but society tends continually to the saving of every foot-pound; the struggle for higher efficiency, larger output, greater intensity of return, goes on often through present disorder and friction and waste, but goes on steadily to the inevitable goal. It is because we saw the Panama Canal to be, beyond all question or comparison, the most efficient means to a vast and long needed economy in the world's traffic, that our faith in its final adoption and completion has held firm from the first.

The triumph is the more brilliant because, first, of the high place of interest to which the world, now awake to its immense importance, has advanced the canal enterprise; and second, because of the apparently crushing series of adversities through which in this case truth has had to struggle into life. It has suffered from reckless extravagance and financial dishonesty; from drastic reorganization and long years of apathy and financial starvation; from calumny and moral assault and battery, by open and secret enemies; from lobbying and political machinations by opposing transportation schemes; from direct and insidious perversion of popular opinion; from the foolish avarice of accredited agents; from obstinacy, prejudice, misstatement, and ignorance; from Senator John T. Morgan and Minister Concha; from the Nicaragua-or-nothing party at Washington, and the blind and greedy politicians at Bogota. It survived, because it was the fittest; Nicaragua, with all its nursing, died because it was unfit to meet modern conditions of economy and efficiency. Let us leave it with its mourners—a few sincere, many hysterical, some bitter. The call of the times is now for the best that the engineering world can give to the construction of the great and long obstructed work.

* * *

ON the political side as on the physical, the problem has outgrown all precedent, and for its solution has required resort to broad underlying principles—the application of fundamental laws which in smaller and more conventional propositions find limited and modified expression. It is the quality of the creative mind—in particular of the engineering mind—to look back of precedent to the data upon which the precedent is founded. To carp at the action of the President in this case as "unprecedented" is as sensible as to condemn the Culebra cut or the Bohio dam. They also are unprecedented, but for that all the more admirable, because they put into newer, larger, and more serviceable embodiment than ever before the elemental qualities of stability and strength, and serve a larger usefulness than anything that has gone before them.

Speaking of these two very things—Culebra and Bohio—the late George S. Morison once said to me: "You must look at these problems in a large way; when you do, the solution is plain and the difficulties disappear." The controlling conditions for our Government were not the fleeting political configuration of an unstable and equivocal State, but truth to the basic purposes of our Isthmian policy, honesty toward the actual owners in fee of the property we sought to acquire, and faith to our duty to give the world the best possible waterway from Ocean to Ocean. Whatever criticism the President may now receive from those to whom a part seems greater than the whole of our duty—or from those who honestly believe our duty to be something else—if he succeeds in carrying his purpose into execution along those broad and fundamental lines, he will swing his countrymen and the world at large to perception of the soundness of his course, as they have been swung to understanding of the supreme merit of Panama as an engineering project. And he will deserve and receive the praise due to him who sees the Truth behind the Form, and if need be, dares to break through the form to free it.

* * *

THE Ship-Building Trust, as seen in the light of recent disclosures, seems to occupy "that bad eminence"—the climax to the campaign of conscienceless industrial promotion, through which the Napoleons of Finance have been leading their wretched dupes. And the battle which is being fought by the bondholders gives every promise of being the Waterloo of the campaign.

The example is highly instructive—especially for thinking engineers. As a basis for the promotion we find an enterprise of wide reputation and known prosperity. The Bethlehem Steel Works are the very embodiment of the genius and practical wealth-creating talent of a long line of engineers and works managers. They suggest a galaxy of names of which that of John Fritz is the foremost, but of which all are identified with some commanding advance in industrial science. With the entry of the speculative financial "mind," the creative engineering element disappear, but their work lives after them, and this was the bait with which the flotation trap was set for the supposed hordes of hungry investors. The mere savor of profitable business was thought enough to lure them. They are so gullible! So the shining bait was sunk in three or four times its bulk of water. And lest they [illegible]t get even a taste, the master minds in the swindle planned so to tie up this rich bit that by no chance should the victims get any of it. They were not to have even a dilution of the value they thought they were buying—nothing, but plain water.

The trouble with the execution of the contemplated programme was first that the public had grown very shy, through much hunting, and kept away from the trap; and second, that those who did get caught made such an outcry that helpers came running in, turned on the light, and exposed the entire scheme of high finance most shockingly to the gaze of an unsympathetic public which has since been calling it hard names.

The whole affair supplies another impressive example of the resistless power of economic truth—resistless to crush and sweep away that which contradicts it as to uphold and establish that which accords with it. The trust promoters had almost persuaded the world that finance—the new finance of which they were the discoverers and high practitioners—was something quite superior to old-fashioned common sense and wholly independent of old-fashioned common honesty. Political economy was obselete. Wealth was no longer to be the product of labor—"accumulated labor." It was a product of the minds of the Napoleons of Finance. It was a capitalization of what labor was expected to produce—or rather of what they could persuade the public to believe labor might produce. The tokens of part ownership in this "wealth" they called, with delicate irony, "securities," and as the volume of the new sort of "wealth" was bounded only by the imagination of the Napoleons, it leaped to the thousands of millions.

It was marvelous—while it lasted. It would have been very beautiful—if it had been true. But after a short era of Aladdinized prosperity, two discoveries, made at practically the same time and dependent one upon the other, upset the whole scheme. The first was a discovery by the people, that the millions called into being by the mind of the financier existed *only* in the mind of the financier. They were different in that respect from the millions created by the genius of the engineer, which have visible physical existence in the form of mines, factories, machine works, and other wealth-reproducing entities. The financiers' millions needed very much bigger figures to count them, but they weighed just exactly as much as the engineers' millions that had been put into them—not one ounce more. And when, as in some cases, they represented nothing that the engineer had done, but only the creation of the "financial genius," it was found that they had no substance at all.

The second discovery was by the Napoleons of Finance. It was extremely simple, but very discouraging to the Napoleonic purpose. It was that their "securities" had become absolutely unsalable. They could issue them—millions of them—but they could not exchange them for a pair of boots. It had been a good game (for the promoters) while it lasted, but the fun was over. Not even the name that was once greatest in Wall Street had any more power. The whole race of Napoleons was discredited, the dynasty outcast. What is saved from their lately dazzling empire will be saved by the engineer. It will be the recovered and restored body of real wealth around which the promoter threw his flimsy and dangerous "industrial" structures.

* * *

WE perceive with surprise and regret that a committee of the American Society of Mechanical Engineers recommends that the yield point be not considered in testing iron and steel, but that the ultimate strength alone be used.

This is not the place to inquire too closely into the reasons which led the committee to take such a peculiar action; doubtless they will be fully explained in the discussion which will be given to the matter at the meetings. Of course it is well understood that the proper determination of the yield point requires the careful operation of the testing machine at such a moderate speed as to avoid the misleading effects of inertia, but we cannot assume that the recommendation of the abandonment of the yield point from the standard specifications has been influenced by any desire on the part of the committee to encourage the operation of testing machines at unsuitably high rates of speed. Possibly some new discovery in methods of testing will be made public, or some hitherto unknown relation between the ultimate resistance and the actual elasticity of the material. We shall await the revelation with much interest, and be most happy to present it to our readers, should such be the case.

REVIEW OF
THE ENGINEERING PRESS.
"THE WORLD IS ITS FIELD"

THE ELASTIC LIMIT OF METALS.

NATURE OF THE CHANGE IN THE MOLECULAR STRUCTURE OF METALS WHEN SUBJECTED TO PERMANENT DEFORMATION.

Society for the Encouragement of National Industry.

THE question as to the real existence of a "yield point" in the case of materials subjected to a stress, has been discussed of late from various standpoints, and in some quarters there has appeared a disposition to dispute the existence of any such stage in the resistance of metals under load. Under these circumstances, the recent investigations of M. Ch. Frémont, published in a recent issue of the *Bulletin de la Société d'Encouragement pour l'Industrie Nationale,* demand notice and review, showing as they do the behavior of metals when subjected to deforming stresses.

According to the position taken by Lebasteur, the conception of an elastic limit involves the supposition of the existence of a period during which the deformation is instantaneous, a matter upon which a difference of opinion exists. The physicist, by using the most precise methods of measurement, is able to show that permanent deformations are produced by the lightest stresses, and by the use of suitable recording devices M. Frémont has been able to demonstrate that successive applications of slight stresses are able to produce successive small permanent deformations in the frame of a machine intended to be subjected to much larger operative loads.

It is possible, however, to show that although small stresses will produce permanent deformations, the successive applications of small loads will cause these to become smaller and smaller, until no further appreciable set appears. These phenomena, however interesting to the physicist, may therefore be neglected in studying the strength of materials from the viewpoint of the constructor. The existence of an absolute limit of elasticity, is a matter which is contrary to the general experience of mankind, since absolute permanence of any physical structure is hardly conceivable, hence the term should be taken rather as relative to the behavior of the material on either side of such an assumed limit.

According to the French commission for standardizing methods of testing, three definitions of the elastic limit are given: (1.) The theoretical limit of elasticity; this being the maximum load per square millimetre of original section which produces no permanent extension. This limit is supposed to be measured by observing the fact that within a quarter of an hour after the removal of the load the test piece returns to its original dimensions within a thousandth part of a millimetre in a length of 200 millimetres. (2.) The proportional limit of elasticity; this being the point at which the deformations cease to be sensibly proportional to the loads. This limit is supposed to be determined by measuring the extensions to within a thousandth part of a millimetre for successive loads of 1 kilogramme per square millimetre. (3.) The apparent limit of elasticity, or point of origin of deformation under constant load; this being the load per square millimetre of original section under which the extension continues appreciably without the addition of further stress. This limit corresponds to the drop of beam, or fall of pressure-column in the testing machine. As a matter of fact it is practically impossible to determine exactly the relation of the proportional limit of elasticity to the theoretical limit. By some observers the proportional limit is placed above the theoretical limit, while by others it is stated to be below. M. Frémont gives a number of curves from records of tests showing how such differences of opinion arise from the different behavior of various specimens under test. As a matter of fact, the records of specimens differ under successive increases of load from those obtained under successive decreases, the action in such instances being similar to the behavior of indicator springs under rising and falling pressure tests.

In view of the diversity of opinion regarding the elastic limit, M. Frémont has undertaken to investigate the real action which takes place within a metal under stress, for the purpose of determining what he calls the true elastic limit. As long ago as 1830, it was assumed that a metal had passed its elastic limit when it had undergone a change of texture. At that early date any such change could be observed only after considerable extension had occurred, but with modern methods and appliances, including the use of the microscope in the examination of highly polished surfaces, it is possible to distinguish structural changes much more precisely.

When a substance is non-homogeneous, but is composed of several constituents, each constituent has its own elastic limit, and even when the substance is chemically homogeneous, there may exist several orders, each having its own elastic limit. In practice it is necessary to determine only the minimum elastic limit, as occurring at the moment of the first apparent deformation.

The microscopic examination of materials which have been subjected to stress reveals the fact that some metals show a sudden change in texture with the attainment of a certain stress while others alter their structure gradually as the load is increased. These changes are usually clearly visible if the highly polished surface is examined under a magnifying power of about 50 diameters, and when the sudden change appears the whole surface assumes a granular texture, while for those materials which yield gradually the alteration appears in isolated areas, these gradually merging into each other.

It is well known that when a metal is hammered, pened, rolled, or otherwise subjected to local stresses which exceed the elastic limit, the portions become locally hardened, and this fact has led M. Frémont to consider the effect of partial and localised stresses upon pieces under test. Experience has demonstrated that when a metal is subjected to stress in a testing machine the first deformations are local, and it is this irregular distribution of strain which renders it so difficult to maintain the stress in the exact axis of the test piece, either under tension of compression, there being a constant tendency of the line of stress to shift with the shifting resistance. In order to localise the stresses, so that the true elastic limit may be determined by microscopic observation, M. Frémont recommends the use of a test-piece of diminishing cross section, with the object of localising the maximum stress within a limited area in which the microscopic observations may be made. Numerous photographs of tests upon such pieces showing the extent to which the effects may thus be concentrated are given, under flexure as well as under tension and compression. The whole subject is one which demands fuller examination and discussion than can here be given, but the general conclusions are as follows:

The theoretical elastic limit is the average load per unit of section under which the true elastic limit is attained at a definite point of the piece under test. Its value depends, not only upon the given limitations of elongation and of contraction of section, but also upon the adjustment of the test piece and the precision with which the test is made. It is not the elastic limit of the metal, but only the elastic limit of the special piece under the particular conditions of the test.

The relation of the proportional limit to the theoretical limit of elasticity, is, as has already been said, very indefinite. Its value depends to a great degree upon the local deformations, and in cases in which both tension and compression occur, one may counteract the effect of the other.

The apparent limit of elasticity, the so-called "yield-point," is the average load per unit of section at which the true elastic limit is reached in all parts of the metal. It approaches more closely to the true elastic limit than does the theoretical limit, but it must not be confounded with it, since the stress is not uniformly distributed over the whole section, owing to the local hardening which takes place under the localization of strains. It is only when the conditions of the test are such that the stress is closely localized, so that marked local hardening cannot occur, that the theoretical and the apparent limits of elasticity agree closely with the true elastic limit.

M. Frémont affirms that there is but one elastic limit for a given metal, the one which he calls the true elastic limit, and this can be determined only by observation, under proper conditions, of the effects of stress in producing strain in the material; such a limit alone having the characteristics of a physical constant. The various elastic limits which it is customary to employ may involve very serious errors, and they should be subordinated to the production and study of discontinuous deformations, which continually occur in practice, under conditions which it is impossible to predict.

MECHANICAL ROAD VEHICLES.

DEVELOPMENTS OF AN IMPORTANT MECHANICAL INDUSTRY IN THE FACE OF UNINTELLIGENT OPPOSITION.

W. Worby Beaumont—Society of Arts.

IN the course of recent Cantor lectures delivered before the Society of Arts Mr. W. Worby Beaumont says some interesting things about the progress which has been made since he addressed the society upon the same subject in 1895, and compares the advantages which existed even then on the Continent with the restrictive ideas which even yet are prevalent in England. At that time, as Mr. Beaumont says, there were but few makers of automobile vehicles, few users, fewer who knew much about them, and no makers in England.

"These things have changed very much since then; there are many makers, very many users. Many or most of the users are well-satisfied owners; and some believe they know more about what a vehicle should be than the makers do. Many of those who do not use them know that no one ought to be allowed to do so.

"Easy and quick transport for man and things is as interesting a problem to-day as it ever has been, even although there is less to learn now than there was in the time of the English pioneers of three-quarters of a century ago.

"A large part of the world is engaged in moving the other part, or in moving things for it. In fact, it may be said that nearly all the world gets its living by moving people, or things or materials of some kind—from the collier who moves coal from its resting-place to the member of Parliament who moves a resolution that automobiles be numbered, and automobilists be hanged, or transported at some rate less than 12 miles per hour."

Since 1895 legislation has modified somewhat the handicap which has hampered the development of the motor-vehicle industry in England, so that mechanical laws have been permitted to control at least some of the limits to progress, instead of being thwarted by unintelligent opposing prejudice. The principal difficulty which appears in existing legislation is the tendency to introduce technical details into a general Act instead of laying down general principles and leaving the working details to be settled by experience.

With the development of the mechanically propelled vehicle in France and Germany popular interest in motor carriages was aroused and since 1896 there has been steady progress. The great mistake which British makers made, however, was their unwillingness to adopt the results of the experience of those who had had greater opportunities.

"They were not satisfied with the best results obtained by our friends across the Channel, and they were misled by the imperfect knowledge they possessed of the means by which those results had been attained. So they commenced to make a new engine or gear and car, or both, that should be, as they thought, better than the things made abroad. They most of them made scrap instead. A good deal of this was due to the misguided criticism that was frequent in this country, and some of it was also due to the fact that many who were accustomed to steam-engines and traction-engines, and also to gas-engines, imagined that the one thing needful was some simpler form of motor than that they saw either in the Daimler vehicles or the Panhard and the Peugeot, all, or most of them fitted with the Daimler motor. The experience of some years afterwards showed that although there was apparent complication in the governor gear and the apparatus for moving the exhaust valve, as it was found in the Daimler engine, the Panhard and others, the complication was more in appearance than in reality. At all events no engine has been found to run very much better, or continued to run better, than these engines."

The growth of the motor vehicle industry has had an influence upon certain lines of machine work which cannot be too highly estimated, and for the combination of strength, lightness, and high-class workmanship there is nothing which can compare with the results of the efforts of the leading builders of automobiles.

"The motor carriage builder attempted in some matters what the experienced engineer knew to be impossible with the materials employed. This was done in most cases by the amateur who dared, or who in ignorance attempted, what seemed to be a daring thing to the initiated. Failure, however, did not daunt him, and when his gear failed because it was too small for the material he used he did not increase size and weight as an engineer would have done, but called for better and better materials, then for better and better workmanship and better processes, until to accomplish his aims at strength, lightness, power, and speed, he has used and is using materials and workmanship that engineers would only of thought of using for the finest of standards or tools, or for the most costly apparatus of torpedo and gun work. He has called for these things until he has paved the way for the use of materials of extraordinary mechanical properties, and of machine tools and methods which will make the production of the best as cheap as that of the worst. Nothing but the best of everything could have accomplished the feats that have become common since 1896.

"Just as the cycle maker persisted so has the motor carriage maker persisted, and he is doing to-day that which was absolutely impossible only a few years ago. He has stimulated the efforts of the engineer, the machine-tool maker, the metallurgist, the chemist, the india-rubber manufacturer, the textile fabric maker, and the coach-builder. He has, however, only been enabled to do this through the support of the rich purchaser, who, by indulging in a costly sport, has provided the funds which have made possible the development of the vehicle for the many and for trading purposes."

THE REGULATION OF THE MISSISSIPPI.

A DISCUSSION OF THE PROBLEM OF THE BEST METHOD OF CONTROLLING THE FLOODS OF THE MISSISSIPPI.

L. M. Haupt—Journal of the Franklin Institute.

AMONG the various efforts which have been made to direct the great forces in nature for the use and convenience of man, probably none has demanded a greater portion of his energy than those involved in the control of great rivers. The periodical rise of large streams, dependent upon the changes of seasons and climate, has been a matter of study from the dawn of history, and even to-day we are but realizing *the plans* which were made for the regula*tion of the Nile* as considered by the engineer priests of ancient Egypt. The older methods of river regulation, following early ideas for regulation of all sorts, included the so-called "correction" of the natural course of a stream, assuming that the water did not know what was its best channel, and planning to confine the flow to a narrow and straight way, altogether different from any found in Nature. The modern method, more rational in its conception, seeks to provide suitable outlets for the temporary excess flow, and aims to follow the natural tendency of the stream, only guiding it in such a manner as to prevent injury to the works of man, to enable it to reach its ultimate discharge to the sea with the minimum of disturbance and the maximum of flexibility.

In the United States the Mississippi river has always been the object of study and effort at regulation, this naturally following because of its magnitude, and the great extent of its drainage basin, and also because of the important section through which it flows. Government commissions have studied it, and large sums of money are yearly appropriated for its improvement and control, and yet it continues to be a cause of danger and destruction with the return of every season of flood.

In an interesting address recently delivered before the Franklin Institute, and published in the *Journal* of the Institute Professor Lewis M. Haupt discusses the methods which have hitherto been employed in the attempts to control the floods of the Mississippi, and indicates in general the existing conditions and methods of treatment.

The natural resource of an individual who seeks to protect his property against floods is to construct an earthen dam, high enough to keep the water out, and in the early history of settlements along the Mississippi, this was the plan adopted by the farmers and planters to protect their property. From the joint efforts of neighboring property holders to extend such dams, the existing system of levees on the lower river has doubtless grown, and while the efficacy of the method in local protection may be admitted, experience with is as a general system has not been encouraging. On the contrary, the result of the elevation of the river banks has been to induce a corresponding elevation in the bed of the stream, the remedy thus working its own defeat.

"It has been said by them of old time, that 'All rivers run to the sea, yet the sea is not full; unto the place from whence the rivers come, thither they return again.' While this is true of the waters of the rivers it is not true of the sediment which they carry. The millions of tons of rain, aided by the frost and winds, denude the mountain fastnesses, so rich in mineral and fertilizing elements, and feed *it to the* great hydraulic conveyors which transport it to and deposit it upon these garden spots of the earth, built up of the material supplied by the mountains.

"It is stated that since the mouth of the river was at Commerce, just above the Ohio, the deposits have covered some 40,000 square miles, which have been reclaimed from the Gulf and elevated to a height of 285 feet at Cairo, sloping both laterally and longitudinally, so that the river runs on the ridge which it has built up from the bed of the Gulf.

"This feature of alluvial rivers is manifest by a glance at the delta, which so clearly exhibits the process of land structure by the long, tapering salients which carry the several arms of the stream far into the Gulf, instead of permitting it to escape down the shortest and steepest slope to the level of the sea. A cross-section of the river also shows the elevation of the banks to be the highest along the borders of the stream, and that it falls away in the distance at the average rate of about 3 or 4 feet in each mile, so that the overflow drainage is away from the river and into the bayous and swamps which are its natural sedimentation basins.

"It has been estimated that the volume of sediment carried into the Gulf each year varies from 250,000,000 to 278,000,000 cubic yards, but it is also stated that the banks are constantly caving at the rate of about 9 acres per mile of river and that their average height is from 30 to 45 feet, which would contribute about 332,000,000 cubic yards to the bed of the stream, independently of the amount fed by the tributaries, which is no doubt much more, so that the net amount of sediment left in the bed would exceed that deposited in the Gulf, if it be prevented from spreading beyond the bank by levees. Hence it must follow that unless the ejecta are equal to the injecta the excess must contribute to elevation. This may readily be accepted as a fact when it is seen that a single flood may cause deposits on a level amounting to from 6 to 12 inches of mud."

In seeking some other method than the use of levees for protection against disaster by floods, Professor Haupt calls attention to some physical principles, which, *while* they may appear to be rather elementary, point the way to relief. In the first place, there can be no overflow if the capacity for outflow be made sufficiently great. In other words, floods are caused because the water cannot get away fast enough. In the second place, the capacity of a stream for the transport of solid matter decreases rapidly with a decrease in velocity. With the diminishing slope of a river, as it approaches its mouth, the sediment which it carries must diminish in size, so that the coarser gravels and shingle are deposited in the upper reaches, and cannot be carried throughout the entire length of the stream and delivered to the Gulf.

Accepting these premises, the true method for relief, according to Professor Haupt, is not to depend upon the production of local scour by local contractions, since these contractions act as dams, checking the discharge from the portions above, and do as much harm as good. Rather, he suggests, remedial measures should be undertaken with the aim of preventing the troubles, instead of attempting to restrain them after they have acquired practically uncontrollable force.

"These remedial measures must evidently be directed towards the prevention of simultaneous floods and accumulation of large volumes of water, which must be carried in a congested conduit for long distances before it can find relief, and therefore no single system will fulfill these requirements but a combination of impounding reservoirs on the tributaries, especially of the western sections, where they may be utilized for irrigation; reforestation of the arid regions; levees with a readjusted alignment and low-weirs at suitable points for spill-ways, to be connected with large subsiding reservoirs in the swampy bayous; and, finally, by the removal of the bars at the delta and opening of all the available and possible outlets to permit of a rapid voiding of the excess of the floods. By such a combination it is believed the navigable channel will be deepened and be made permanent, the flood plane will be lowered and less arable land be inundated, the height of the levees will not have to be constantly increased, the discharge will be retained for a longer period in the lateral basins, from which it may be fed to the main trunk to sustain a nearly uniform stage and water be stored for irrigation, which is already becoming a necessity in the lower valley because of the exclusion of the flood waters by the levees."

POWER GENERATION FROM HEAT.

THE RELATIVE EFFICIENCIES OF VARIOUS KINDS OF FUELS FOR THE DEVELOPMENT OF MECHANICAL ENERGY.

Dr. Carl von Linde—Verein Deutscher Ingenieure.

ONE of the noteworthy papers presented at the recent convention of the *Verein Deutscher Ingenieure* was that of Dr. von Linde, the well-known authority and inventor in the field of artificial refrigeration, and in the general domain of applied thermodynamics. Taking as his broad subject the conversion of the heat produced by the combustion of fuel into mechanical energy, he examined the present existing methods of making this conversion, for the purpose of indicating the most efficient process and the most effective machines to be used in this process. For a century and a half the steam engine has been employed by man to act as his means of compelling the force stored by Nature in *combustibles to do his* work. Is this machine and this process to continue, or are we on the verge of the replacement of the steam engine by some other form of motor and some other process of force conversion?

While disclaiming the idea of contributing anything new to the discussion of this important question, Dr. von Linde begins by considering the fundamental principles in a very thorough manner, taking the quantity of heat under consideration as represented by the area of a rectangle with an altitude measured up from the temperature of absolute zero, thus plunging at once into the so-called "heat-diagram" without any confusing preliminaries. He thus shows clearly that the first aim in the design of a heat motor is to receive the working medium at the highest possible temperature

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the high efficiency of the gas engine are several, and these Dr. von Linde proceeds to examine by means of the heat diagram. In the first place, the temperature-range is far higher than is possible with steam, even when superheated at high pressures; and in the second place, the losses due to the initial condensation in steam engines are altogether absent. Dr. von Linde emphasises especially the influence which a high degree of compression exercises upon the efficiency of an internal-combustion motor. The effects of high compression are two-fold. In the first place the higher working pressures permit a smaller engine to be used for the development of a given amount of power, and in the second place the increased combustion pressure is accompanied with an increased temperature, this bringing with it an increase in thermal efficiency due to the greater temperature range. Thus, in the latest gas engines of the Otto type, according to the investigations of Professor Meyer, the total heat in the fuel is divided into three parts, one-third being returned in indicated power, one-third going off with the heat in the exhaust gases, and the remaining third being absorbed in the cooling water of the cylinder jacket. In the case of the Diesel motor, operating with a much higher degree of compression, as much as 42 per cent. of the heat energy in the fuel reappears as indicated power in the cylinder, this being the maximum thermal efficiency which has as yet been attained in any machine for the conversion of heat into work.

Passing to the broader question of the future possibilities for the application of the various forms of heat motors in industrial operations, Dr. von Linde shows that this depends upon other considerations as well as upon the actual thermal efficiency. The development of mechanical energy is not always to be considered by itself, being often involved with the conversion of the latent energy in the fuel into heat and light as well as into mechanical power. The production of heat, like that of electrical energy, involves two factors, volume and intensity, so that we have to deal both with the quantity of heat and with the temperature. Although the actual amount of energy, as expressed in heat units, is the same for a definite quantity of heat, regardless of the absolute temperature, yet, as has been seen, the efficiency of the processes for the conversion of that energy into mechanical power depends upon the range of temperature which can be employed. In many cases, however, low pressures are necessary for industrial reasons, as in the examples of sugar refining, or of beer brewing, where large volumes of low-pressure steam must be used. The heat available in such instances may be converted into mechanical energy to advantage by the use of such a machine as the waste-heat engine perfected by Professor Josse; or, in many instances higher pressure steam may be first used in a steam engine, the exhaust steam being subsequently employed for heating and evaporating. In such situations it is evident that the superior thermal economy of the internal-combustion motor would not appeal, since the heat for the evaporating machinery would then have to be provided in addition to that supplied for power.

The rapid development of the central station for the generation of light, heat, and power has materially changed the nature of the problem of converting the energy in fuel to the highest advantage. Instead of the single conversion of heat into mechanical energy, there appears the triple transformation into light, heat, and mechanical power, usually through the medium of electricity. Here the use of gas fuel appears to be the best method of attaining the highest efficiency, although up to the present time such installations have not been made on the largest scale. It is possible, however, that the generation of electricity in a central station may not meet all the requirements, since the possession of an ample supply of low-priced fuel gas may lead to the distribution of energy in the gaseous form, the conversion into mechanical energy, into light, and into heat being made at the point of application, by the use of the highly efficient internal-combustion motor, the incandescent gas burner, and the economical, smokeless gas heater.

THE METRIC SYSTEM IN ENGINEERING.

RESPONSES TO QUESTIONS PUT TO THE FRENCH SOCIETY OF CIVIL ENGINEERS BY THE AMERICAN CHAMBER OF COMMERCE IN PARIS.

Société des Ingénieurs Civils de France

ABOUT a year ago there was a paper presented before the American Society of Mechanical Engineers by Mr. F. A. Halsey, discussing the inconsistencies of the countries supposed to have adopted the metric system, and showing that even in France the old measures persisted to a surprising degree. The paper elicited widespread discussion, and drew to the meeting the Director of the Bureau of Standards from Washington, as well as the member of Congress who was most active in endeavoring to push the compulsory adoption of the metric system in the various departments of the Government, and the question occupied a large portion of the time of the convention. The bill for the compulsion of the use of the metric system did not become a law, but the question is still open, and hence the further agitation of the matter is a subject for comment and review. As a sort of sequel to this discussion comes the publication of a series of questions and answers, the former being put by the American Chamber of Commerce in Paris, and the latter supplied by the *Société des Ingénieurs Civils de France;* the whole being published in a recent issue of the *Mémoires* of the Society.

The method of imparting instruction by question and answer is not a new one, but in most instances the questions and answers emanate from the same individual. We can hardly imagine that the residents of Paris who compose the American Chamber of Commerce need themselves to be informed and hence it is reasonable to assume that they have adopted this method of enlightening their brethren across the sea concerning the merits of the metric system. At the same time the subject is elucidated in an interesting way, and some of the points are presented in a clearer manner than has been heretofore published. For the entire catechism the reader must be referred to the original publication, but some of the more important points may here be noticed.

In the first place the inherent superiority of the decimal system of notation is taken for granted, and indeed many people seem to think that there is something inspired about this rather primitive idea. Based, as it is, upon the first crude methods of counting upon the digits of the hands, it is not surprising that it has attained a sort of historical vogue, but this can hardly be taken as a mathematical argument. As the Greek and Roman systems of counting were obliged to give way before the more useful Hindu, miscalled Arabic, system of notation, so, it may well be believed, we shall hereafter employ something still better, possibly based upon the logarithmic progression, and certainly having greater flexibility and scope than the method now in vogue.

Leaving aside, then the responses which tacitly assume that the decimal notation is in itself all-sufficient, we may proceed to a broader consideration of the whole problem. It is admitted, in the answers to the first three questions, that the metre has no definite relation to the dimensions of the earth, and that the metric units of length, weight, and volume possess no precise relation to each other. This eliminates some of the strongest arguments which have been made for the metric system, and clears the air accordingly.

Following these come some curious references to the centigrade thermometer, as if this formed any portion of the metric system. It is, indeed, common for some people to consider that the centesimal thermometer scale belongs to the metric system, but we must confess ourselves surprised to find this position taken by a body of scientific men. If, however, the thermometer scale is to be considered at all, the one which should demand acceptance among the ordinary scales is that of Réaumur, based as it is upon the uniform expansion of mercury, one degree representing 1/1000 of the volume of the bulb, and the number of divisions between two temperatures of water being altogether a secondary consideration. It is generally accepted, however, among scientific observers that the true basis of temperature measurement is that of the expansion of a perfect gas, starting from the absolute zero, so that the thermometer question need not be brought into the discussion at all. There are several side excursions into the popular subdivisions of the coinage of the Latin Monetary Union, but as these relate to the decimal subdivision of the unit, they do not bear upon the main point under serious consideration, that of the difficulties inherent in the general introduction of the metric system into Anglo-Saxon communities. The employment of the nautical mile, and its derivative, the knot, as well as of the fathom, in marine measurements is discussed, and it is maintained that the persistence of the nautical mile is dependent upon the sexagesimal system of angular measurement, the mile being a minute of arc upon the surface of the earth, while when (?) the centesimal system of angular measurement is fully introduced the kilometre will occupy this eligible position. It is, however, admitted, that there is a practical necessity for uniform practice among all marine nations, and hence that system of measurement which is employed by the leading maritime nation of the world must be accepted as a matter of course by those less active on the sea. A similar admission is again made in connection with the use of the carat as a unit of weight by jewellers, this practice being confessed to be due to the necessity of yielding to the practice of the more important nations with which the bulk of the business must be transacted.

When some of the more important matters, relating to the effect of the system of units adopted upon the volume of trade are reached, the responses become less definite, and, indeed, are sometimes rather evasive. Thus, inquiries as to the effect of the employment of the bushel, gallon, and pound, upon the shipment of American goods to France, are met by the response that it is difficult to answer, and that anyhow, the questions of price and quality outweigh such matters. The extent to which the use of the metric system has influenced the importation of manufactured products into France is answered by showing that since 1900 the imports into France from the United States had diminished, while those from metric-using Germany had increased. The influence of the use of the metric system upon the external commerce of France is not stated, nor are the other controlling trade influences of the countries named during the period mentioned. An inquiry as to the extent to which mechanical and other industries were in existence at the time of the origin of the metric system is met by the statement that at that time France was in a state of upheaval, and not really a fit subject for such a comparison. A better instance is that of Germany, which in 1872 was undoubtedly an active manufacturing and commercial empire, and in which no serious disturbance was caused by the adoption of the metric system. As a matter of fact, Germany was at that time most seriously inconvenienced by the multiplicity of existing arbitrary units, and the replacement of these by a single system naturally proved most acceptable.

We believe that the whole question of systems of weights and measures has been given a consideration altogether beyond its importance. Uniformity is desirable, but not at the expense of more serious matters, and the idea of extolling a means to the dignity of an end is to be deplored. The system which is the best will prevail, and no amount of artificial forcing will cause a defective method to persist. A machine must depend for its success on its merits, its cost, its real value, and not upon the system of measurement employed in its design and construction. The metric system has many advantages, although we believe that these have been exaggerated, and the British system has its defects, many of which have also been magnified. In every case, however, the success of the manufactures and the commerce of any nation must depend upon the intrinsic merits of the goods and the skill of the men, and against these any system of weights and measures sinks into insignificance.

MODERN COKING PROCESSES.

THE REGULATION OF THE COMBUSTION AND DISTRIBUTION OF THE TEMPERATURE IN COKE-OVEN PRACTICE.

D. A. Louis—Iron and Steel Institute.

IN a paper recently presented before the Iron and Steel Institute, Mr. D. A. Louis reviewed the development of modern coke ovens, examining the growth of by-product oven and examining especially the latest improvements in coking practice in the Westphalia district.

The satisfactory coking of coal involves the maintenance of the proper temperature, this temperature depending both upon the nature of the coal and upon the stage in the process of coking.

"There is probably no one who would assert that all kinds of coal should be coked at the same temperature, or that a uniform temperature is desirable throughout the whole of the coking operation, although nobody would contest the fact that the temperature should be distributed appropriately but uniformly whether it be a higher or a lower degree of heat. Hence it is that the regulation and distribution of the temperature in coke ovens have always offered attractive fields to inventors and improvers; and by the middle of last century a whole host of workers had suggested one thing or another to attain the desired end, including burning the washed or unwashed gases in flues around the coking chamber. However, it was Carvès who combined many of these disconnected notions. He investigated the matter sedulously, and found that with the coal he had to deal with—a poor non-caking coal—a high temperature rapidly and evenly distributed throughout the coal in conjunction with closed carbonising chambers, were the conditions for obtaining good coke, and at the same time a good yield of ammonia and tar rich in aromatic substances. It was he who improved the arrangement of the horizontal side flues in which the washed gases were burnt to heat the coking chamber; he too who insisted on the narrow chamber to ensure the desirable rapidity of carbonisation. In the early form the residual gases returned to the ovens were burnt over a solid fuel fire in a grate built for the purpose in the lower part of the walls separating the coking chambers. The heated and burning gases then circulated in two side flues, ascended to the uppermost of the three horizontal flues in the wall, and thence descended these in succession on their way to an inclined flue, which connected the lowest horizontal flue to the subterranean waste main leading to the chimney. In this scheme the highest temperature was developed under the ovens, and thence decreased in intensity in the order stated, and all the regulation of the combustion and the temperature took place at the grate. Later on the grate was abolished, the heat for the coking being derived wholly from the combustion of the gases, air being admitted under pressure to support the combustion, and therefore by controlling this air supply the combustion and the temperature could to some extent be regulated. Then came the notion that it would be better to supply hot air, and Simon introduced his arrangement in which, by allowing the air for combustion on its way to the ovens to pass through passages running between the underground waste gas mains, the heat from these gases passed to the air, which became intensely heated, and as a result the sole of the coke oven also became so hot that to avoid inconvenience from burning out the two flues of Carvès were replaced by a single flue, made of the most refractory material, so as to stand the heat; the gases then followed the same order of progress as in the old Carvès ovens, and in fact the effects produced in those ovens also obtained in the Simon-Carvès ovens, but in a greatly intensified condition, and would certainly meet with the approval of those authorities who advocate heating in the order indicated, and maintaining the same temperature throughout the whole period of coking."

The horizontal flued oven has passed through a number of modifications, among the most notable of which may be mentioned the Semet-Solvay oven and the Fabry-Linard system. The distribution of heat with horizontal flues, however, was not altogether satisfactory, and hence the vertical-flued system came into use, the first type of this design being due to Coppée. This was followed by the Otto-Hoffman oven, in which there was a violent pre-heating, first both of the air and the gas, but later of the air only. The earlier forms of these ovens were provided with regenerators of brick checker work, but in the later types, such as the Otto-Hilgenstock ovens, a form of Bunsen burner is adopted, there being a concentrated intense combustion at frequent intervals near the bottom of the ovens and a diminishing, although high temperature elsewhere.

The latest types of ovens in use in Germany are those of von Bauer and of Brunck.

"The Brunck ovens resemble other coke ovens in having long chambers supported on a substructure. The Brunck substructure is, however, one of some complexity, as it contains an elaborate series of connecting ducts, cooling channels, checkerwork chambers, and vaulted conduits. These arrangements serve for the removal of the waste gases and for preheating the air supplied for combustion, as well as conducting it to the points where it is required. Moreover, to ensure a better distribution of the heat the ovens are heated from each end independently, hence all the substructural arrangements are in duplicate. The coking chambers are built on the top of an upper row of cooling passages; arched chambers are first constructed, separated by good solid walls, and within these the coking chambers proper are built with a longitudinal flue below each chamber, whilst vertical flues arranged on each side of each chamber with a general longitudinal flue above connect with the lower longitudinal flue below. The lower flue is divided into four sections by parting walls, and a parting wall extending all round the outside of the coking chamber at the centre completely shuts off one side of the surrounding space from the other, and separates the flues of one end from those of the other."

The firing of the Brunck ovens is effected by gas jets at each end, the burning gases ascending the side flues and descending at the centre, the air being heated in a checker-work between the flues. These ovens are provided with a by-product recovery plant, and the waste heat is used for the generation of steam.

The von Bauer oven is another variant of the vertical-flued horizontal oven, somewhat resembling the Brunck design, but rather simpler in construction. The air supply enters between the combustion chambers, the air openings being carefully arranged so as to maintain the combustion exactly at the right points. Each side of the median wall is kept separate from the other, besides which the flues are divided into groups, the better to permit regulation and control. Each oven can have its temperature regulated separately, and can have its gas directed through the by-product works, or to the gas main, as may be desired. In this way the various stages of coking in each oven may be controlled independently of the others. The charging is effected through the top, and all the advantages of the discontinuous ovens are united with those of the continuous by-product system. Such an oven can produce 170 tons of coke in twenty-four hours with a yield of 74 per cent. of the coal, while the saving of the by-products renders the process a very economical one.

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GRINDING AS A MACHINE-SHOP PROCESS.

THE DESIGN AND USE OF THE GRINDING MACHINE AND GRINDING WHEEL C
AS MACHINE TOOLS.

C. H. Norton—National Metal Trades Association.

ALTHOUGH grinding has been in use as a machining process for many years, yet its true nature and scientific use still remain to be understood in many establishments. For this reason the paper by Mr. C. H. Norton before the National Metal Trades Association demands notice and abstract, especially in view of the wide practical experience of its writer in this particular department of work.

Mr. Norton reviews the early history of the development of grinding as a machine-shop process, and shows that its original use was as a finishing process to work which had already been brought very close to size in the lathe, and which was ground only with the intention of increasing the accuracy of the product.

"Twenty years ago grinding was considered essential to really good work by concerns that now enjoy the best patronage of the enitre world, and fifteen years ago they had reached the point where it was impossible to produce their work as cheaply without grinding as with it. The best grinding machines of to-day will produce from four to six times more work than those of twelve years ago; and yet, while large numbers of American machine builders are using modern grinding machines, there is a class who demand proofs in the way of tests, etc., before they can believe
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The cost of machines and wheels melts into insignificance before the saving on single pieces."

Viewed in this light the grinding wheel must be considered as a kind of milling cutter, with millions of teeth which cut until they are nearly worn out, and as they wear off are constantly replaced by others equally sharp. That this is really the action of a proper grinding wheel is seen by the appearance of the chips under the microscope. An actual curly chip is seen, and from the sizes and forms of the chips the character of the wheel by which they were made can be determined.

Formerly grinding was considered as a process adapted to small work demanding a high degree of precision, to-day it is employed for finishing a piston rod 12 inches in diameter and 12 feet long with a limit of accuracy of 0.00025 inch. In such a case it is easy to save from three to four days of lathe work with one day's labor on the grinding machine, so that the economy of the process is evident.

"There is a prevailing belief that grinding does not pay except with quantities of duplicate work. Everyday practice proves this belief to be without foundation, and the modern grinding machine, with modern grinding wheels, stands ready to take to a finish still cheaper turning than has yet been done, and we await the more general introduction of heavier lathes to give us still cheaper turning."

FLOW IN CENTRIFUGAL PUMPS.

ESEARCHES ON THE MOVEMENT OF FLUIDS IN CENTRIFUGAL PUMPS AND ALLIED MACHINES.

es Alex. Smith—Victorian Institute of Engineers.

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of centrifugal pumps and similar machines, Mr. Smith sought to demonstrate by ocular experimental methods, the actual occurrences when a liquid is propelled by a revolving wheel in a closed case, and he has devised some very ingenious apparatus for aiding in this study. Taking the facts thus demonstrated he has deduced some conclusions as regards the form of runner best adapted for practical results, the whole forming a combined practical and theoretical study of much interest.

The apparatus used by Mr. Smith consisted of two separate instruments, named by him the vorteximeter and the volutimeter; the first being designed to analyze the vortex or whirl in the runner, the second, the spiral current in a given casing.

"In the vorteximeter fluid, or fluids, are supplied through a revolving shaft to a space separating two glass discs fixed pulley-wise upon the spindle. The discs are kept apart by pieces of card representing vanes. When the general stream outline alone is required a single colored fluid suffices; but when in addition the sliding over each other of integral laminæ is to be followed, two fluids must be used; the greater flow then consists of ordinary water, the lesser of filamentary streams of colored liquid injected into the main issue.

"To measure the forms and motions of streams resulting from a high velocity of rotation, advantage is taken of the fact that the eye is capable of recognizing objects illuminated for an exceedingly short period —certainly less than 1/100,000th of one second—provided the light is of sufficient intrinsic intensity. Hence, if the rotating discs be lighted for a period so short that the angular motion during that time is negligible as compared with the magnitude of the movements to be observed, it follows that the disc will appear at rest. If, further, it is arranged that successive illuminations shall occur when the vanes are in the same relation to a fixed point, and at intervals of not more than one-tenth or one-seventh of a second, then the disturbance of the retina will continue between flashes, and the brain will receive the impression of a constantly illuminated object at rest, if the phenomena observed be constant. If there be a sequence of phases they will blend into a series giving the effect of change in a non-rotating body.

"The speed of rotation of the discs is, of course, a quantity dependent upon the hydraulic problems to be treated, but whatever that speed may be with suitable adjustment, the discs seem stationary, although at low speeds the light may flicker.

"In the volutimeter it has not, so far, been found expedient to rotate the runner. The instrument consists of glass planes separated by paper templets representing the casing to be tested, but the equivalent of the runner is fixed, and with orifices of efflux so designed that the effluent, supplied under pressure, shall at exit pursue a path as nearly as possible coincident with that of the discharge from an actual given runner. Flow is rendered apparent by mixed streams, but special illumination is not requisite."

These instruments are both arranged for use in the projecting lantern, and also adapted for the production of photographic records of the stream-line curves developed under various conditions. In the paper presented last year, a number of reproductions of curves are given, and the experimental side of the subject principally discussed.

The second paper, which has recently been presented, contains the practical discussion of the information obtained by further experiments, showing the influence which they may have upon the design of centrifugal pumps, and materially simplifying the work.

As Mr. Smith says: a centrifugal pump is an apparatus for imparting accelerated motion to a particle and then utilising the resulting momentum to produce pressure. In the design of such machines there are two important questions to be determined, the form of the vane and the section of the runner passage. The pressure head which can be imparted to the water is determined, not by the velocity considered in relation to any part of the runner, but to the maximum absolute velocity; what Mr. Smith calls its projectile velocity in space. The acceleration must be derived from the angular velocity of the runner, and since this must increase with the increment of radius it follows that with uniform rotative speed, radius alone, irrespective of form, governs the velocity of a point in a vane of any contour. This fact, fully confirmed by Mr. Smith's experiments, is of especial interest, since much of the effort which has been given to improve the centrifugal pump has been directed toward the determination of the proper form of vane. There is no doubt that curvature of the vane may alter the distribution of the work, and may serve to deflect the discharge towards a tangent or a radius, but curvature, of itself, cannot cause acceleration, nor can it increase the acceleration due to the circular motion at any point.

Mr. Smith has experimented in his apparatus with runners of various curvatures, both concave and convex, the path of the particle being photographically recorded in each case, and the results have fully confirmed his argument as to the superior efficiency of the straight radial vane. With this vane the actual path of a particle is the logarithmic spiral, the experimental results being practically the same for speeds ranging between 200 and 2,000 revolutions.

The proportioning of the section of the passage through the runner is governed by the condition that the width should be inversely as the velocity. This condition is met by giving the leading wall of the passage a hyperbolic curve, a result fully confirmed by the experiments.

Reference must be had to Mr. Smith's original paper for his detailed conclusions, and also for a description of his "spiragraph," or instrument for tracing curves under conditions similar to those occurring in centrifugal pumps. The methods which he has adopted are both interesting in themselves and valuable for the light which they have thrown upon a problem in machine design concerning which information has been much needed.

ELECTRIC MOTORS FOR PUMPS.

A DISCUSSION OF THE PROPORTIONS OF MOTORS FOR PUMPS AND FANS UNDER VARIOUS CONDITIONS OF OPERATION.

A. J. Bowie—American Institute of Electrical Engineers.

WITH the introduction of electric driving for all kinds of machinery it is most desirable that the capabilities and peculiarities of the motive power should be understood and appreciated by those to whom the arrangement of the whole plant is intrusted. The differences which exist between electric power and steam or other older methods are such as to lead to unsatisfactory results unless proper judgment is used. A special case which demands attention is that in which an electric motor is employed to drive a centrifugal pump or a fan blower, and the especial adaptability of the electric motor for such work renders the question one of interest. In a paper recently presented before the American Institute of Electrical Engineers, by Mr. A. J. Bowie, this subject is discussed in a manner both interesting and valuable.

"The problem of determining the proper capacity of a motor for driving centrifugal pumps and fans, is not always easy to solve. The solution is too often the result of guess-work, and is liable to be seriously in error. In the case of direct-acting pumps working against a known head, the proper motor capacity can be easily calculated. The most economical size of motor for the purchaser, however, may not be solely determined by the possible loads, and their duration, which the motor may be called upon to carry. Particularly is this true where a flat rate system is in vogue and where power is purchased at a price depending upon the rating of the motor and not upon the power actually used. This system of charging for power leads to great abuse in the underrating of motors; on the other hand, it may work a great hardship on a purchaser of power who innocently uses a motor far larger than is necessary and pays for power that is not consumed. Several instances of the latter have come under the writer's observation, and the system in his opinion should be condemned. Where measurements of power are taken at a basis for determining the flat rate, such measurements should be taken under the average running conditions. A variation in these conditions may lead to a very erroneous system of charges in the case of centrifugal pumps and fans, as will be seen.

"For centrifugal pumps and fans the power required for operation at a rated speed and head is by no means all that need be known. One should also know the maximum load which can ever come on the motor when driving the pump or fan at the rated speed and under any possible head. This maximum may be far in excess of the rating."

Three conditions are discussed by Mr. Bowie; constant speed with varying heads changing speed with head varying as the square of the speed, and constant head and varying speed. For each of these equations and diagrams are given, enabling the user to make his computations.

"The behavior of centrifugal pumps may be represented very completely by four curves. These curves are based upon an absolutely fixed speed. Corrections for variations from this speed may be made without difficulty. These curves have, in each case, for abscissæ, the volumes of the fluids delivered in a fixed time interval, while for ordinates they have respectively, head, watts input to pump, watts output from pump, and pump efficiency. The last two curves determine the proper rating of the pump. In general, the maximum efficiency occurs before arriving at the point of maximum output. The proper rating is somewhat indefinite, as will appear from the appended curves obtained in practice. The natural tendency of a manufacturer is to rate his pumps as high as possible. Still, he does not care to go far beyond the point of maximum efficiency at the full load rating."

Probably the case which occurs most frequently in the operation of centrifugal pumps is that of constant head, the speed varying according to the quantity of water discharged. In this case according to the computations of Mr. Bowie, the power varies about as the 3½ power of the speed.

"From this it may be seen what an extremely large effect speed variation has on motors driving centrifugal apparatus. There is perhaps no other form of apparatus so sensitive of change of speed in its power consumption. The effect which a steady pump load has in holding the voltage constant by preventing the racing of generators is thus explained. If centrifugal apparatus be provided with induction or synchronous motors then the speed is practically fixed by that of the prime mover so that the maximum load for the motor with a given pump or fan is determined. Speed control of direct-current motors by variation of field resistance has a limited range in practice and has many points which tend to make it objectionable for the best conditions of commutation. Even at best there will be considerable field distortion at the high speeds. The effect of a load which would increase as the cube of the speed, and even faster would seem to limit still further the allowable speed variation to be obtained in this manner. In view of these facts it is well to provide a motor of ample size for such work and at the same time to see that the field rheostat cannot cut in so much resistance as to overload the motor. As has been shown, the volumetric output of a centrifugal pump varies directly as the speed of revolution. In spite of this fact, many manufacturers rate their pumps at a fixed volumetric output, and publish a list of suitable speeds for different heads under which it may be desired to operate the pump. In some cases the highest speed given in these lists is three or more times as great as the lowest speed. Such misinformation leads to a great deal of trouble and cannot be too strongly condemned."

THE INSTRUCTION OF APPRENTICES.

MODERN METHODS OF TRAINING WORKMEN IN THE ART OF USING TOOLS AND SHOP PROCESSES.

Robert Patterson—Canadian Railway Club.

THERE is no doubt that the apprenticeship question is one of the most important which at present confronts the industrial world.

New tools and improved methods may and do reduce the number of men required to produce a given article, but this very fact creates a wider market and provides work for more men, so that with the increasing field of work more and abler men will constantly be demanded. The old-time seven-years' apprenticeship belongs to a period when primitive methods obtained on all hands, and surely the advances which have been made on all other sides should extend to the process of making workmen as well.

An excellent paper on the training of apprentices was recently presented before the Canadian Railway Club by Mr. Robert Patterson and from this we make some abstracts bearing upon the salient features of the problem.

"The question of instructing apprentices to make good mechanics of them is harder to deal with than in the past. At present there is a desire among the apprentices themselves to take advantage of present-day opportunities to obtain instruction in drawing and other subjects. Many of the older mechanics, however, who have not had similar advantages, do not like to see apprentices become efficient or able to do a man's work along certain lines, which they are able to do in a great many cases, after having been in the service only a short time. It is this influence exerted over the apprentices with which we have to contend. Being young, the apprentices are easily influenced. Some of the older mechanics, who have not enjoyed the privileges of better education and better system of learning a trade, and who belong to organizations which are not interested in progress, have a tendency to influence the apprentices against their own self-interests. The apprentices are led to believe that employers who wish to educate them and make good men of them have some ulterior object in view. The older mechanics are afraid that the coming generation will be won from allegiance to the unions, and will become more loyal to their employers. They therefore endeavor to create in the minds of the apprentices the idea that the highest object in a trade is to get as much money as they possibly can for their services from the commencement, rather than to become first class workmen, and ultimately merit better wages and higher positions."

Mr. Patterson describes the preliminary examination into the moral, physical, and mental qualifications for a boy to fit him for apprenticeship, these being about the same as would qualify him for trying for an entrance examination to a high school. He also describes what is a very important detail in the methods employed in the shops of the Grand Trunk Railway, the provision of a book of rules for the guidance of the apprentice, showing him the nature of the examinations which he is to pass in the succeeding stages of his career. In each department the apprentice is under the supervision of the foreman, the time for him in the various departments ranging in length according to the importance of the work. Thus in the boiler shop or the coppersmith shop the time may be from six to twelve months; in the machine shop about four years is required, this being divided up into periods of about six months each on the drill press, planer, and vise, about eighteen months on the lathe, and the balance of the time in fitting, steam connections, and minor details, then passing to the erecting shop to complete the five years' course.

A most important feature in the system advocated and used by Mr. Patterson is that the various examinations which are held in the passing of the apprentice from one department to another include instruction in the machines and processes which he is about to undertake, so that a theoretical knowledge of the work is given before the work is begun, and with but a little instruction from the foreman work may be begun at once.

"As at each examination the apprentice is required to make a drawing, it is necessary for him to be instructed in mechanical drawing, and companies and corporations should furnish the means for him to obtain this education, and it should be furnished entirely free. While it is an advantage to an apprentice to get the instruction, it is also an advantage to the corporations to have their apprentices instructed. There should be two classes, one senior and one junior, and it should be made imperative for all apprentices to attend. A roll book should be kept showing the attendance, and this should be carefully scrutinized by the master mechanic, general foreman or person in charge of the works, and tardy apprentices should be looked after. Those who are particularly attentive and show ability should have a term in the drawing office when possible.

"Wages of apprentices is governed largely by conditions and localities, but good fair wages should be paid, so that the best material should be available. Mr. Patterson also believes that as soon as an apprentice has completed his term he should be at once recognized and paid according to his ability. If he is capable of earning the best wages in the shops, he should receive them. If not, he should be paid in proportion. If an apprentice knows that when he is out of his time, if he has ability, he will command the best wages in the shop, it will be an incentive to him to devote all his energies to learning his trade, and make a good man of himself during his term of apprenticeship."

Mr. Patterson discusses the question as to the legal binding of apprentices, and is led to advocate it, largely because its absence enables unscrupulous employers to benefit by the methods of training to entice apprentices away from the shops where they have been taught, and to which the later and more valuable portion of their services are due.

"Some firms, when they are busy and short of men, find that a boy who has served two or three years is capable of doing their special work, and entice him away, regardless of his moral obligation to complete his apprenticeship. This practice cannot be too strongly condemned. It is bad for the employer, and still more injurious to the apprentice, as it is apt to cause dissatisfaction with wages and with employers. Recommendation or service papers should not be given to any apprentice who leaves his employers before his time of agreed service has expired, unless he is compelled to do so for some special reason which is acceptable to them."

FIRE PROOF CONSTRUCTION.

INFLUENCES OF METHODS OF BUILDING CONSTRUCTION IN PREVENTING THE SPREAD OF CONFLAGRATIONS.

Perez M. Stewart—International Association of Fire Engineers.

PREVENTION is now everywhere accepted as better than cure wherever it can be applied, and in nothing does this hold truer than in defense against fire. In some directions excellent progress has been made in the application of scientific principles to the construction of buildings with respect to the prevention of fire, but the development has been very unequal, and there is much yet to be learned and applied. In a paper recently presented by Hon. Perez M. Stewart before the International Association of Fire Engineers the extent to which modern fireproof construction affords added fire proctection is discussed in a manner which is of serious interest. Mr. Stewart calls attention to the value and importance of experiment stations for the investigation of matters connected with fire insurance, such as the insurance engineering experiment station conducted by the New England Mutual Fire Insurance Companies in connection with the work of the Massachusetts Institute of Technology in Boston, the testing station of the National Board of Fire Underwriters in Chicago, and others, and shows that fire protection is now a well-defined department of the work of the engineer with continually increasing scope.

"A careful consideration of the matter of fire protection should convince every owner that the introduction of safeguards against fire will bring a fair return in reduced rates on the increased outlay, besides fulfilling a moral obligation which he owes to his lessees, tenants, neighbors and himself.

"Several theatres in New York have had their insurance rates materially reduced because of changes in their construction made at the instigation of the Department of Buildings. That the fireproof character of a hotel is a most desirable advertisement is indicated by the fact that some proprietors who cannot honestly claim that characteristic, attempt to deceive their patrons by untrue representations. One of the large hotels of New York maintains a room in a burnt condition as an indication of what can happen in a fireproof hotel without the knowledge of any of the patrons or the proprietor. A fire that originated in this room nearly burned itself out before anyone was aware of it."

An important point upon which Mr. Stewart lays proper emphasis is the inequality in regulations for buildings which, while of different kinds are equally important as fire risks.

"Municipal regulations all over the country provide for almost every contingency which may occur affecting human life in theatres, or other places of public assemblage. Department stores, however, seem to be passed over entirely in the requisites of the City Fathers. Theatres and their management are provided for by a code as long as the moral law. In the case of department stores, however, probably three to five times as many people are allowed to congregate, to the square feet of building occupied, and yet no adequate provision for their safety is made.

"At the present time, however, many owners of department stores realize not only the moral duty they owe to humanity in safeguarding its interests, but also the benefit they receive in insurance rates by making their stores as fireproof as possible.

"The concentration of commercial interests as embodied in the department store of to-day concerns vitally the fire hazard. Combining an almost infinite variety of industries, the department store represents, so far as the fire hazard is concerned, an aggregation of many individual fire hazards."

Mr. Stewart proceeds to discuss the principles involved in efficient fireproofing, considering the subject from the point of internal and external protection, both in connection with the materials employed and the manner of combining them.

"Among the materials most commonly used in building construction which are generally considered incombustible, may be enumerated the following: brick, stone, terra cotta, wire glass, iron, steel, and concrete. By such incombustible materials is meant those which will not burn or produce flame when subjected to a heat of 2,000 to 3,000 degrees Fahrenheit. Incombustible materials are not necessarily fireproof. It is important that this should be kept in mind.

"By fireproof materials is meant such as not only do not burn, but which, under the action of fire, remain intact and preserve their strength, or the strength of those parts which they protect."

The so-called "slow-burning" system of fireproof construction meets with scant consideration by Mr. Stewart and he cites several instances in which solid wooden construction has been completely destroyed while concrete-protected steel construction withstod the flames. Elevator shafts especially demand protection, since even under the best of cases they naturally become great flues through which fire is transmitted from floor to floor. Vertical passages in walls may often be avoided, but when they are necessary they may be provided with frequent fire stops to break the upward draft.

One of the most important risks in connection with fire protection is found the external exposure, and it is from risks of this sort that the modern fireproof building should be carefully protected. Theoretically the best protection in this respect consists of solid brick walls, but in practice windows and other openings are necessary. Metal shutters, or better, wooden shutters covered with metal, have been adopted, but these have the defect of concealing a fire which may be starting within. A better material is found in wire glass, since this is both transparent and impervious to fire.

Mr. Stewart does not profess to give anything but a bare outline of the modern principles of fire protection, but he has pointed out in no uncertain tones the importance of correct engineering work in the choice and use of materials, and shows very clearly the wide field which the subject affords for study and experimental research.

THE GROWTH OF THE SUEZ CANAL.

A REVIEW OF THE DEVELOPMENT OF A GREAT WATERWAY IN RESPONSE TO THE DEMANDS OF TRAFFIC.

Glasers Annalen für Gewerbe und Bauwesen.

THERE is at the present time an increasing interest in the development of waterways, both internal and international, and a growing belief that water transport will continue to hold its own for all purposes in which economy is a controlling consideration. Since much of the future work to be done in this department of engineering must be guided by past experience, the very full account given in a recent issue of *Glasers Annalen* of the manner in which the capacity of the Suez Canal has been increased is timely and valuable.

The original plans for the Suez Canal, as laid down by the International Commission in 1856, provided for a channel having a total length from breakwater to breakwater of 156,957 kilometres, there being eleven straight portions, ranging from

985 metres to 53,655 metres in length, joined by curves of 5,000 to 15,000 metres radius. The depth of the canal was to be 8 metres, to permit the passage of ships drawing 7.24 metres of water; the width was 80 metres at the surface of the water and 44 metres at the bottom, for the section from Port Said to the northern end of the Bitter Lakes, and 100 metres and 64 metres, from the Bitter Lakes to the Red Sea These dimensions were modified in the actual structure, which, as completed in 1869, consisted of 13 straight portions, with connecting curves of 1,011 to 3,192 metres radius. So far as the cross section was concerned this varied at different points. A number of wide spaces were provided to permit the passage of ships, but the bottom width of the prism was in most places only 22 metres, instead of 44, while the depth varied from 6.71 to 7.32 metres, there being one shallow of 5.49 metres depth, due to the presence of rock.

In 1870 and 1871, after the canal had been in active operation, the channel was deepened by dredging, until the full depth of 8 metres was attained throughout the entire length, and the draught of the steamships traversing the canal ranged from 6.91 to 7.21 metres. The traffic steadily developed, the number of vessels passing in both directions increasing from 486 in 1870 to 1,457 in 1876, the tonnage increasing from 436,609 tons to 2,096,772 in the same period. During this time little or no work was done to improve the canal, but the pressure of the increasing traffic began to be felt, and after the control passed into the hands of the British government it was decided that a million francs should be expended yearly in improvements. It was expected that after 30 years this expenditure would so increase the capacity of the canal as to enable it to provide for a yearly traffic of 10 million tons.

The extension work at first was devoted to the widening and lengthening of the turnout stretches of the canal, thus facilitating the passing of vessels by each other, while at the same time the terminal harbors were improved. From 1876 to 1883 the traffic continued to progress, the tonnage increasing from 2,096,772 in 1876 to 5,775,862 in 1883. During this period the dimensions of the vessels began to show a marked increase, reaching 139 metres length, 15.40 metres in breadth, and 7.50 metres draught. In 1883 153 vessels of more than 7 metres draught passed through the canal, showing the impending necessity for an increase in depth.

In 1883 the so-called "London programme" for the improvement of the canal was discussed, the question being as to the advisability of constructing a second parallel channel or the widening of the existing canal. At first it was suggested that the canal be widened from Port Said to the 130-kilometre station and that a second channel be constructed from thence to Suez. This plan, however, was superseded by a decision to widen the entire channel, the base width being increased from 22 to 65 metres and the depth made 9 metres throughout. This work was intended to permit vessels to proceed at a speed of 8 knots, while the provision of electric lighting would enable traffic to be conducted during the entire 24 hours. The widening was started in 1886, as well as the electric lighting, and in the following year the deepening to 9 metres was begun, this latter improvement having become imperative, owing to the increasing draught of vessels.

Notwithstanding the increased capacity which these enlargements have provided, still further improvements are under way, and the bottom depth is to be 75 metres, with an increase to 90 metres on the curves. The cost of this work is estimated at 101 million francs, and it is expected to provide for the requirements of the next 20 years.

At the present time the maximum speed permitted in the canal proper is 10 kilometres per hour. For a distance of 15 kilometres through the small Bitter Lake this is increased to 15 kilometres per hour, while between the lighthouses in the great Bitter Lake a speed of 22 kilometres is permitted, the distance being 16 kilometres. This gives a possible minimum time of transit of 14 hours, 44 minutes. Before the installation of the electric lighting, in the period from 1876 to 1886, the average time of transit was 41 hours, 56 minutes, of which 23 hours, 37 minutes were consumed in stops at night, so that the actual time of transit was 18 hours, 19 minutes. Since the introduction of electric lighting in 1886 down to 1900 the average actual time in transit is 16 hours, 48 minutes.

The actual traffic through the canal is fully tabulated from 1884 down to 1900, and the growth is seen to be steady and continuous. Thus the total tonnage in 1884 was 5,871,501, and this had increased to 8,039,175 in 1894, and to 9,738,152 in 1900. That this increase was only possible by reason of the improvements made in the canal is evident from the fact that the total number of vessels in 1900 was only 3,441, while there had been 3,284 in 1884, and as many as 4,207 in 1891, the increased tonnage being mainly due to the greater dimensions of the vessels. Thus in 1884 the largest vessel passing through the canal was of 5,665 tons, while in 1900 the largest ship measured 13,402 tons. The receipts in 1884 were 62,638,964 francs, and this had grown to 90,707,007 francs in 1900.

The continuous growth of the traffic through the Suez Canal and the extent to which increases in capacity have been followed by increases in traffic and in receipts, are ample evidence of the extent to which facilities create traffic. Future waterways in all parts of the world may well be constructed with possible enlargements in view, and just as the harbors of the world must provide ample depth, dockage, and facilities for the continually increasing dimensions of ships, so must ship canals be designed to meet the continual demands for increased capacity which they are certain to create.

THE UTILIZATION OF EXHAUST STEAM.

LOW-PRESSURE STEAM AND ITS APPLICATION BY MEANS OF THE HEAT ACCUMULATOR AND THE STEAM TURBINE.

Julius Divis—Oesterreiche Zeitschrift für Berg und Hüttenwesen.

IN a recent paper upon the steam turbine, published in this Magazine, M. Rateau gave some facts as to the success which he had attained in the operation of low-pressure steam turbines with the exhaust steam from reciprocating engines. This forms a most interesting development in the practice of utilizing exhaust steam, and the method demands attention and discussion in view of its possible importance. The process is discussed in a paper by Inspector Julius Divis, published in a recent issue of the *Oesterreiche Zeitschrift für Berg und Hüttenwesen*, of which we give some review.

M. Rateau has shown that the energy in the exhaust steam of high-pressure engine may be utilized to advantage in a turbine, while at the same time the addition of a condenser enables the effect of the pressure of the atmosphere also to be secured. These facts may be shown, as he has done, by theoretical computations, but the practical application of the system includes some interesting devices. In the first place it has been demonstrated that when properly proportioned, the efficiency of a low-pressure steam turbine operated in connection with a condenser, is very nearly as high as when greater steam pressures are employed, the turbine in this respect differing essentially from the reciprocating steam engine, the efficiency of which falls off to a marked degree with low pressures. There is therefore no difficulty in placing a steam turbine in the exhaust discharge of a reciprocating engine, so far as efficient working with steam pressures of one or two pounds above the atmosphere is concerned, and this M. Rateau has done with success.

The principal practical difficulty encountered in the use of exhaust steam in a turbine lies in the periodical nature of the discharge of the exhaust, especially in the case of large engines operating at slow speeds, such as pumping engines, and the like. This difficulty has been met by M. Rateau in the construction of what he has termed a steam accumulator, a device for the storage of heat and the equalization of pressure. The general construction of this device is readily understood. It consists of a large vertical cylindrical vessel, containing a number of ring-shaped dishes of cast iron, these rings being made very heavy in order to provide a sufficient mass of metal to absorb the heat from the steam. These dishes are so arranged that the exhaust steam is obliged to circulate through and within them and come into close contact with all portions.

The water of condensation which comes over with the steam is directed to passages leading directly to the bottom of the accumulator, so that it may be drawn off, and the whole device forms practically a large steam separator, with the additional feature of the provision of heavy masses of metal for the absorption of heat. The effect of this arrangement is to abstract heat from the highly heated discharge of steam which enters at the beginning of each exhaust stroke of the engine, this heat being again given out to the steam in its passage through the accumulator to the turbine. The result is an equalization of pressure, producing a flow which is very nearly uniform at the discharge, while the return of heat practically equals that absorbed, so that the efficiency of the apparatus is very high. Experiments have shown that with a properly proportioned accumulator the variation in pressure can be kept within such limits that the turbine speed does not vary at most 2 per cent.

With this device, and with the addition of a suitable condenser, the exhaust steam of even a slow-moving pumping engine may be used to high economy in a steam turbine, without interfering in the least with the operation of the original engine. If it is desired to insure operation of the turbine at all times a separate pipe is used, together with a pressure regulator, so that steam from the boilers may be used if the reciprocating engine for any reason is stopped.

Professor Rateau has made various modifications in this apparatus to adapt it to different conditions, and in some cases he advocates the use of an intermediate turbine, the back-pressure of the reciprocating engine being raised to 25 or 30 pounds, and the steam passing through the accumulator to the intermediate turbine and from this to a low-pressure turbine. The lower range of pressure in the original engine thus enables it to work to better advantage, owing to the reduction in cylinder condensation, while the full expansive power of the steam is obtained in the turbines. Such a combination forms a variety of triple-expansion engine, of which the cylinder forms the high-pressure member, while the two turbines correspond to the intermediate and low-pressure elements, respectively.

The various modifications of the principle of the low-pressure turbine operated by exhaust steam are seen to offer great possibilities for the improvement of existing steam plants where the present arrangements cannot well be so materially changed as to permit the installation of an entirely new equipment. In this respect the Rateau system offers points of advantage which in some features render it superior to the waste heat engine of Professor Josse. There is no volatile liquid to be handled and condensed, all the work being done with steam. No difficult packing boxes are required, and the exhaust from the turbine may be discharged into a central condenser, if one is already installed, or any of the independent condensers now on the market may be employed. Apart from these conveniences the turbine does not involve any direct mechanical connection with the engine, but runs independently, both as to speed and power delivery. Indeed, as has been seen, some of its most effective applications have been made in connection with winding and pumping engines, in which the character of the movement is altogether different and with which previous systems of compounding are not always available.

Apart from the application of the low-pressure turbine as an auxiliary to reciprocating engines, the system presents opportunities for convenient arrangements of new plants, using turbines altogether. The present forms of multiple turbines will doubtless be the best for continuous work in large units, where a large expansion ratio and high efficiency are desired. It would be entirely practicable, however, to produce a triple or multiple expansion system in which as many independent turbines would be used, each having its own speed and connections, and each taking the steam from its predecessor until the lowest pressure of discharge into the condenser was reached. It is quite possible that such arrangements may find useful applications where the larger multiple expansion turbines would not be available.

The flexibility which is thus appearing in the application of the turbine principle in steam engineering adds another to its many advantages as a prime mover, and will doubtless hasten the time of its displacement of the reciprocating engine for the great majority of uses as a source of motive power from steam.

EFFECT OF WIND ON ROOFS.

A REVIEW OF THE EXPERIMENTAL INVESTIGATIONS OF IRMINGER AND THEIR INFLUENCE UPON ROOF DESIGN.

Theodor Nielsen—Engineering.

SEVERAL years ago we referred in these columns to the important and interesting experiments of Mr. Irminger upon the action of wind pressure upon various forms of structures, and emphasised especially the suction effect of the wind upon gasholders, roofs, and similar constructions. A further study of this subject appeared in this magazine from the pen of Mr. Robert Neilson, in January of this year, and now we have a paper by Mr. Theodor Nielsen, in *Engineering,* applying the results of Irminger to the study of the actual wind stresses upon roofs.

Until recently it has been customary to assume that wind pressure acted in a manner similar to any other statical pressure, and the data obtained from experiments with wind gauges and similar apparatus have been extended to areas far beyond those upon which the tests were made, in application to the proportioning of the parts of framed structures exposed to wind action. The experiments of Irminger, however, showed that, so far from the action of the wind being a steady pressure, capable of decomposition and resolution like other statistical forces, it produces not only positive pressures, but also negative pressures, or suctions, in directions altogether neglected.

The experiments, of Irminger separated the effects of the wind upon the weather and the lee sides, and proved that for planes at sharp angles to the horizon, such as roofs, there is but a small pressure on the weather side, while the lee side is exposed to a heavy suction. These facts render the old theories absolutely worthless, and indicate that in existing designs tons of material have been wasted in rafters, purlins, and ties, while tie bars have been used in the bracing where struts should have been employed, and vice-versa.

Although it is greatly to be desired that Mr. Irminger's experiments be supplemented by others, in order that proper working conditions may be obtained, there is no doubt that his general conclusions are sound; and from his trials Mr. Nielsen has taken certain coefficients and applied them to the computation of the actual stresses upon a roof under the action of the wind In the first place, it is necessary to determine or assume the actual direct pressure of the wind, this being obtained in the usual manner by the employment of wind gauges, anemometers, or the like. Calling this pressure P, certain coefficients are employed to compute the extent to which this pressure is attained on various portions of the structure. On the lee side this coefficient is negative, there being a suction, instead of a pressure, while even on the windward side the actual pressure is but a portion of the total measured force. Thus, according to Irminger's experiments, the pressure on the walls of houses, ventilators, and sheds may be taken as 0.42 P on the windward side, and a suction of 0.36 P on the lee side. For roofs inclined at an angle of 45 degrees the pressure on the weather side is given at 0.22 P at the eaves, and the corresponding suction on the lee side as 0.525 P. These figures indicate the difference between the experimental distribution of pressures and those ordinarily assumed, and show how differently the material should be distributed in order to obtain the maximum resistance to the action of the wind.

Mr. Nielsen gives a complete graphical analysis of the wind stresses on a roof truss, taking both Irminger's data and constants and the distribution according to the ordinary assumptions, so that the differences may readily be compared. The reversal of stress, so important in determining the character and construction of certain members, is clearly shown, and in view of this action, it is no wonder that roofs and similar structures have been damaged by wind, even when most carefully proportioned according to the older methods. According to the new analysis, and in full agreement with practical experience, the wind acts to lift a roof off of the building. According to the old theory the wind action may produce total stresses more than double those due to the dead loading, but the new analysis shows a much smaller direct action in most instances, together with a reversed influence upon some members, exposing tie-rods to compression, so that it is astonishing that we have not had more frequent instances of bent and buckled tie-bars. Existing roofs, being calculated according to the old method, are very strong and stiff, so that in many cases the suction simply acts to oppose the dead load. In one instance the mean dead load was 15 pounds per square foot, while the suction was 16 pounds, the two thus nearly balancing each other. In such a case the stiffness of the rafters doubtless prevented the buckling of the tie-rods. A striking example of the suction influence on roofs is given by Mr. Irminger in the case at Copenhagen of a roof, 300 feet by 40 feet, this having been lifted wholly off of the building and deposited in a basin of the harbor, some 100 feet away. An examination of the roof showed that the rafters on the lee side had bent outward, proving the existence of the suction. It is well known that the peasants in Switzerland and other mountainous countries load the roofs of their cottages with heavy stones to prevent them from being sucked or lifted off by the action of the wind upon the lee side of the mountains.

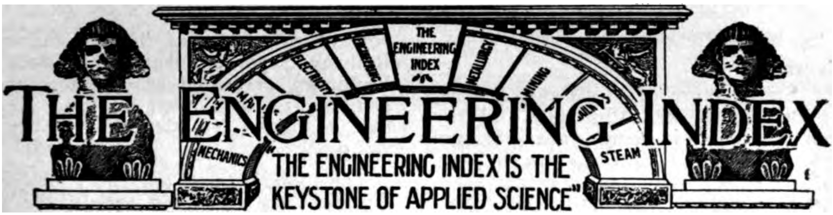
In view of the above experiments and investigations, certain modifications in roof design are suggested, even if the stock of data is not yet complete enough to permit precise formulas to be given. Thus it appears to be advisable never to use any interior tie-rods in a roof truss, but to replace them by stiff sections, capable of acting either as ties or as struts. This precaution may prevent a collapse from a reversal of stress which tie-rods alone would be unable to stand.

According to Mr. Irminger, small flat roofs need not be proportioned for wind pressure at all, the strength required for dead loads being ample, if the precaution is taken to bolt the roof down to prevent it from being lifted bodily upward. For large, flat roofs it is important to consider the suctions on the lee side, since these may cause reversals of stress sufficient to do serious damage. Only for large roofs of halls and similar buildings, and for steep-sided roofs does he consider it necessary to consider the positive wind pressure at all.

These investigations supply explanations for some otherwise mysterious actions of buildings under wind stresses, and should have a marked influence upon details of building design. Thus at St. Louis, during the great hurricane in 1896, various buildings were damaged by the walls bursting outwards, and numerous cases occurred of the outward breaking of windows. Undoubtedly such examples were the result of the combined pressure on one side and suction on the other which has been indicated by the experiments.

There has been much discussion of late as to whether the ordinary estimates of wind pressure have not been excessive. It now appears that they have not only been too large in one direction, but also too small in another. Our structures may not have been too heavy, as has been intimated, but the material may not all have been in the right place.

When these later investigations into the action of wind pressure on structures are considered, it is evident that the whole of the methods heretofore obtaining in engineering practice must be revised. It has been appreciated of late that the results obtained with large wind gauges did not agree with those determined by small gauges or anemometers, however carefully these latter may have been calibrated, but at the same time the pressure, when determined or assumed, was considered as acting positively over the entire area, whereas the modern view shows that the force may be negative at times to an extent capable of reversing the stresses in certain members of the structure. The action upon large covered areas, such as roofs, may be different from that existing with open structures, such as bridge trusses and other skeleton forms of construction. In these cases further experiments may be necessary, but in considering either roofs or the large surface areas exposed to the action of the wind by modern tall buildings, the methods developed by Irminger and worked out by Nielsen and others may well be considered in computing the direction and magnitude of stresses upon the various members.



THE ENGINEERING INDEX

"THE ENGINEERING INDEX IS THE KEYSTONE OF APPLIED SCIENCE"

The following pages form a DESCRIPTIVE index to the important articles of permanent value published currently in about two hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every article.

(1) The full title,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published.

We supply the articles themselves, if desired.

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer and works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of any article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the journals indexed are given.

DIVISIONS OF THE ENGINEERING INDEX.

CIVIL ENGINEERING 447
ELECTRICAL ENGINEERING 453
GAS WORKS ENGINEERING 459
INDUSTRIAL ECONOMY 459
MARINE AND NAVAL ENGINEERING 460
MECHANICAL ENGINEERING 461
MINING AND METALLURGY 469
RAILWAY ENGINEERING 473
STREET AND ELECTRIC RAILWAYS..... 477

CIVIL ENGINEERING

BRIDGES.

Aqueduct.

The Pecos Valley Aqueduct. An illustrated detailed description of a perplexing piece of engineering work in New Mexico. 1200 w. Ry Age—Oct. 9, 1903. No. 58325.

Arch.

A Great Concrete Arch in Germany. Description and illustration, taken from German papers. The bridge is near the town of Neckarhausen. 600 w. Ry Age—Oct. 2, 1903. No. 58227.

The Adda Railway Bridge in Italy. Notes and illustrations from an article by William Wolff, in *Centralblatt der Bauverwaltung*. An illustrated description of a large masonry arch having a single span of nearly 230 ft. on the line of the Colico-Sondrio Railway in Northern Italy. 1700 w. Eng Rec—Oct. 17, 1903. No. 58465.

The Santa Ana Concrete Arch Viaduct. Illustrates and describes a viaduct 984 ft. in length, in California. 600 w. Ry & Engng Rev—Oct. 10, 1903. No. 58375.

Bascule.

The Ashland Avenue Bascule Bridge, Chicago. An illustrated description. 1600

w. Eng Rec—Oct. 10, 1903. No. 58345.

Cantilever.

The Substructure of the Mingo Bridge Over the Ohio River. Illustrates and describes a railroad bridge near Mingo Island, which has a cantilever main span 1,290½ feet long, with a clear center span of 700 ft. weighing 6000 tons. The river is subject to floods which demand great stability and strength for the superstructure. 2000 w. Eng Rec—Oct. 3, 1903. No. 58261.

Costs.

Why Steel and Its Erection Costs so Much. Editorial on the results of the bidding for about 40000 tons of steel for the superstructure of the Blackwell's Island bridge over the East River, at New York. 1400 w. R R Gaz—Oct. 2, 1903 No. 58268.

Drawbridge.

A Novel Type of Drawbridge. Illustrates and describes a type of drawbridge adopted by the Miami & Erie Canal Transportation Co. This company has a charter for operating by electric towage, using trolley locomotives on a track along the towpath. Where the track crosses the canal drawbridges are used. 500 w. Eng News—Oct. 22, 1903. No. 58640.

Erection.

Novel Method of Erection Adopted for the Frans Bridge at Villefranche Over the Soane. From *Annales des Ponts et Chaussées.* Illustrates and describes novel methods of erection of a cantilever bridge. 600 w. Eng News—Oct. 22, 1903. No. 58642.

Incline Bridge.

A Movable Railway Incline Bridge at New Orleans. Illustrates and describes a tilting landing stage for the transfer of trains from Mississippi boats to the tracks of the Texas & Pacific Ry. It is a trussed bridge, fixed at the shore end, but capable of a wide range of adjustment at the river end. 2700 w. Eng Rec—Oct. 24, 1903. No. 58626.

India.

Bridge Over the Rupnarayan (*Pont sur le Rupnarayan*). Illustrated description of a bridge on the line of the railway between Calcutta and Madras. 1000 w. 1 plate. Génie Civil—Sept. 26, 1903. No. 58503 D.

Erection of the Girna Bridge, India. An illustrated account of engineering work of exceptional interest, including sinking of piers and erecting superstructure. 1600 w. Engr. Lond—Sept. 25, 1903. Serial. 1st part. No. 58214 A.

Inspection.

Method of Making Annual Inspection of Bridges and Culverts. Abstract of report of committee of the Association of Railway Superintendents of Bridges and Buildings, presented at Quebec, Canada, Oct. 20-23, 1903. 3800 w. Eng News—Oct. 29, 1903. No. 58677.

Long Span.

The Marietta Long-Span Highway Bridge. An illustrated article, the present number dealing with the stresses, dimensions and deflections of this new bridge across the Ohio River. 3000 w. Eng Rec—Sept. 26, 1903. Serial. 1st part. No. 58138.

Newcastle.

A New High-Level Bridge Over the River Tyne at Newcastle, on the Northeastern Railway of England. F. E. Harrison. An illustrated detailed description of the construction of a four-track structure. 3800 w. Ry Age—Oct. 23, 1903. No. 58661.

New York.

The Comparative Strength of East River Bridges; Existing and Proposed. Letter from W. Hildenbrand, with response from G. Lindenthal concerning the bridges across the East River at New York. Ill. 4500 w. Eng News—Oct. 1, 1903. No. 58183.

Railroad Bridge.

The Pennsylvania Railroad Bridge over the Raritan River at New Brunswick, N. J. An illustrated detailed description of the construction of a fine bridge, with brief review of the removal of the old bridge to a new site without interrupting traffic. Also editorial. 5000 w. Eng Rec—Oct. 10, 1903. No. 58341.

Repairs.

The Kansas City Flow-Line Bridge Repairs. J. A. L. Waddell. A statement, with illustrations, concerning the repair work to the bridge over the Kaw River that carries the pipes for the water supply of Kansas City, which was badly injured by the flood. 5500 w. Eng News—Oct. 29, 1903. No. 58678.

Suspension.

The Vernaison Suspension Bridge. Emile Guarini. Illustrates and describes a semi-rigid suspension bridge of light construction, crossing the Rhone 8½ miles below Lyons. 700 w. Sci Am Sup—Oct. 10, 1903. No. 58371.

Transfer.

The Movement of the Passy Bridge (Le Déplacement de la Passerelle de Passy, J. Feugères. An illustrated description of the manner in which the highway bridge across the Seine between Passy and Grenelle was moved bodily a distance of 29 metres. 2000 w. Génie Civil—Sept. 19, 1903. No. 58500 D.

Viaduct.

The Concrete Viaduct Near Riverside, Cal.; San Pedro, Los Angeles & Salt Lake R. R. A. C. Ostrom. Illustrated description of the arched viaduct crossing the Santa Ana River. 1000 w. Eng News—Oct. 22, 1903. No. 58632.

CANALS, RIVERS AND HARBORS.

Breakwater.

Final Completion of the Buffalo, N. Y., Breakwater Extension to Stony Point. Illustrations of what is claimed to be the longest breakwater system in the world, with facts concerning it. 350 w. Eng News—Oct. 1, 1903. No. 58179.

Canal Traction.

Electric Traction on Canals. (Le Halage Electrique sur Canaux.) Georges Petit. A review of the applications which have been made of electric power to canal traction, showing the conditions under which it may prove advantageous. 3000 w. Revue Technique—Sept. 25, 1903. No. 58509 D.

Cranes.

European Floating and Dock Cranes. Frank C. Perkins. Illustrated description of cranes used in Hamburg harbor. 900 w. Sci Am—Oct. 3, 1903. No. 58174.

Shipbuilding Cranes at Kiel. Illustrated descriptions of cranes in use in the Krupp shipyard at Kiel. 1100 w. Engr, Lond—Oct. 9, 1903. No. 58442 A.

20-Ton Steam Jib Crane. Illustrated description of a type in operation on the new harbor works at Dover. 1000 w. Engr, Lond—Oct. 2, 1903. No. 58305 A.

Dams.

The Correct Design and Stability of High Masonry Dams. George Y. Wisner. Prepared for the Nat. Irrigation Cong. Discusses the problem of constructing dams to withstand the great pressure of water stored for the irrigation of arid lands. 3000 w. Eng News—Oct. 1, 1903. No. 58185.

Erie Canal.

Summary of the Case Against the Erie Canal Enlargement. Editorial review of the arguments that have been advanced. 1800 w. R R Gaz—Oct. 23, 1903. No. 58646.

The Opinions of Engineers on the New York Barge Canal Proposition. Editorial, with letters from prominent engineers in reply to a request for their opinions. 9000 w. Eng News—Oct. 22, 1903. No. 58638.

Floods.

Controlling the Floods of the Mississippi River. Prof. Lewis M. Haupt. Considers the great destruction of life and property by these floods, and gives suggestions of remedies that may be applied to alleviate the disasters. 5000 w. Jour Fr Inst—Oct., 1903. No. 58289 D.

Flood Damage to Bridges at Paterson, N. J. An illustrated article showing the condition of bridges after the flood, and discussing points of interest to engineers. 1600 w. Eng News—Oct. 29, 1903. No. 58675.

Flood Prevention and Irrigation: Twin Ideas. J. R. Burton. Urging that measures be taken to control flood waters, and that the stored waters be used for land irrigation. Considers methods involved. 4000 w. N Am Rev—Oct., 1903. No. 58286 D.

The Floods in the Passaic Valley. Editorial on the destruction caused by the recent heavy rainfall, with remarks on the need of immediate investigation and remedy. 1000 w. Eng Rec—Oct. 17, 1903. No. 58464.

Haulage.

Recent Canal Haulage Improvements. George E. Walsh. Considers recent electric haulage systems, and the general tendency. 1800 w. Ir Age—Oct. 29, 1903. No. 58665.

Kiel.

The Baltic Canal. An examination of the commercial and financial deficiencies of the Kiel Canal, showing the causes to be the low charges and high expenditures. 1000 w. Engr, Lond—Oct. 2, 1903. No. 58303 A.

Lighthouses.

See Gas Works Engineering.

Pier.

Completion of Roker Pier. Illustrated description of a pier, begun eighteen years ago, on the coast of England. 600 w. Engr, Lond—Sept. 25, 1903. No. 58216 A.

The New Roker Pier, Sunderland. General view, plan and sections of a pier which forms one arm of the harbor at the mouth of the Wear. 700 w. Engng—Oct. 2, 1903. No. 58295 A.

Ship Canal.

The Suggested Forth and Clyde Ship Canal. Benjamin Taylor. A survey of the rival schemes for the construction of a deep water ship canal between the Forth and the Clyde. 4500 w. Page's Mag—Oct., 1903. No. 58470 B.

Suez.

The Suez Canal and Its Improvements (Der Suezkanal und seine Verbesserungen). An account of the various improvement works which have been made upon the Suez Canal since its opening, with a table of the traffic. 3500 w. Glasers Annalen—Oct. 1, 1903. No. 58523 D.

Torrents.

The Reforestation of Mountains (Le

Reboisement des Montagnes). A discussion of the regulation of mountain torrents showing the influence of forests upon the distribution of rainfall and the importance of forest preservation and cultivation. 2000 w. Génie Civil—Sept. 26, 1903. No. 58501 D.

Traffic.

Traffic of European Rivers and Canals. Ray G. Floyd. An illustrated article giving information obtained on a tour of inspection of European waterways. 1700 w. Marine Rev—Oct. 8, 1903. No. 58309.

CONSTRUCTION.

Building Construction.

The Twenty-three Story Land Title Building, Philadelphia, Pa. The first article deals especially with foundations, wind-bracing, etc. An illustrated detailed description. 3300 w. Eng Rec—Oct. 3, 1903. Serial. 1st part. No. 58259.

Fireproof.

Fireproof Construction. Hon. Perez M. Stewart. Discusses some phases of modern methods, materials, etc., outlining the essentials in fireproof construction. 4000 w. Am Archt—Oct. 24, 1903. No. 58655.

Foundations.

Action of Sea Worms on Foundations in Boston Harbor. F. W. Hodgdon. Brief illustrated description of the destruction of timber from the outside by worms. General discussion. 3200 w. Jour Assn of Engng Socs—Aug., 1903. No. 58167 C.

Interlocking Metal Piling for Power House Foundations. An illustrated description of coffer dams of unusual construction used by the Union Electric Light & Power Co. of St. Louis in building their power house. 900 w. Eng Rec —Oct. 24, 1903. No. 58628.

Roads.

Latest Progress in Good Roads Construction. Waldon Fawcett. Gives illustrated description of improved machinery, of great power and efficiency, used in the construction of roads. 1400 w. Sci Am—Oct. 3, 1903. No. 58175.

Trench-Work.

Rock Trench-Work, Boston, Mass. Frederick I. Winslow. Brief account of the conditions and practice in this city. 500 w. Eng News—Oct. 22, 1903. No. 58636.

Tunneling.

A New Method of Tunneling Under Broadway, New York. Illustrated description of the system adopted which will cause but little interruption of traffic and present no serious obstacles in the street. 1400 w. Eng Rec—Oct. 24, 1903. No. 58627.

Tunnels.

Harlem River Tunnel of the Rapid Transit Subway. Illustration and description of a difficult piece of engineering work carried out on a new system through difficult material. 1200 w. Sci Am—Oct. 31, 1903. No. 58680.

The East River Division of the Pennsylvania R R. Tunnel at New York City. Illustrates and describes the construction under the East River to Long Island. 1500 w. Eng News—Oct. 29, 1903. No. 58676.

The New York Terminal of the Pennsylvania Railroad. The first of three articles giving an illustrated description of this great undertaking. 2300 w. R R Gaz—Oct. 9, 1903. No. 58349.

The New York Terminal of the Pennsylvania Railroad. The present article illustrates and describes the tunnels to be constructed from the middle of the North River under Manhattan and the East River to Long Island City. 2000 w. R R Gaz—Oct. 16, 1903. No. 58398.

The Pennsylvania Railroad Tunnel Under the North River, at New York City. An illustrated article describing the portion of the line in the North River division. 8000 w. Eng News—Oct. 15, 1903. No. 58403.

Tunnels for the New York City Terminus of the Pennsylvania and Long Island Railroads. An illustrated article describing the plans for this extensive undertaking. The tunnels under the North and East rivers, and the great terminal station forming the most costly and stupendous engineering work for passenger traffic in the history of railroading. 3800 w. Eng Rec—Oct. 10, 1903. No. 58344.

Tunnels for the New York City Terminus of the Pennsylvania and Long Island Railroads. An illustrated description of the East River division of this system, with general matter and illustrations. Also editorial on the specifications. 4000 w. Eng Rec—Oct. 17, 1903. No. 58466.

Wind Pressure.

Effect of Wind on Roofs. Theodor Nielsen. Explanation of a new theory based on the experiments of J. O. V. Irminger. Ill. 3500 w. Engng—Oct. 9, 1903. No. 58437 A.

The Influence of Wind Pressure upon the Stability of Chimneys (Die Grösse des Winddrucks bei der Berechnung der Standsicherheit von Schornsteinen). H. Claussen. A discussion of the positive and negative pressures due to wind action, showing the manner in which existing data may be used for chimneys. 2000 w. Glasers Annalen—Oct. 1, 1903. No. 58524 D.

The Influence of Wind Stresses upon

the Verticals of Framed Structures (Der Einfluss der Windverspannungen auf die Einspannungsmomente der Ständer Eiserner Wandfachwerke). L. Geusen. Discussing especially the wind stresses on the verticals of continuous bridge trusses. 4000 w. Zeitschr d Ver Deutscher Ing—Oct. 10, 1903. No. 58520 D.

MATERIALS.

Asphalt.

The Asphalt Industry of Trinidad. Abstract of the report of the Royal Commission concerning the asphalt industry at La Brea. 2000 w. Ir & Coal Trds Rev—Oct. 9, 1903. No. 58430 A.

Brick.

Silica Brick Making. F. C. Downing. An account of this industry in various countries, with description of the raw material, and method of manufacture. 4000 w. Brick—Oct., 1903. No. 58316.

Building Materials.

Calcareous Brick and Stone Manufacture in Germany. A report concerning these industries, with illustrations of machines used, describing processes, etc. 3300 w. U S Cons Repts, No. 1765—Oct. 3, 1903. No. 58220 D.

Building Stone.

The Weathering of Building Stone in London. An illustrated article on the decay of building stones in large cities, especially in London, with discussion of some of the causes. 2400 w. Quarry—Oct., 1903. No. 58377 A.

Cement.

Certain Vexatious and Fallacious Cement Tests Now in Vogue. D. B. Butler. Read before the Soc. of Engrs. Discusses methods and gives standard specifications for general purposes. 3000 w. Engr, Lond—Oct. 16, 1903. No. 58487 A.

Portland Cement Manufacture. Edwin C. Eckel. Considers the preparation of slag-limestone mixtures. 1700 w. Munic Engng—Oct., 1903. No. 58232 C.

Testing Methods in the Physical Examination of Portland Cement. A. H. Cederberg. Gives results of methods pursued and observations made in 6,238 tests of samples made during the last four years. 2700 w. Min & Sci Pr—Oct. 3, 1903. Serial. 1st part. No. 58333.

Concrete.

Mixing and Placing Concrete Composition. S. H. Lea. Information concerning the Physical characteristics of its ingredients, proportions best suited for different purposes, hand mixing, etc. 6400 w. Mines & Min—Oct., 1903. Serial. 1st part. No. 58148 C.

Some Methods and Costs of Concrete Mixing on the Buffalo, N. Y., Breakwater. Emile Low. Gives information as to the kind and size of mixers used, quantity and quality of concrete, cost, etc. Ill. 2500 w. Eng News—Oct. 8, 1903. No. 58353.

Enameled Brick.

A Method of Making Enameled Brick. Lawrence E. Barringer. Describes the work of making white enameled brick of good quality, as developed by experimental investigations, and notes facts of interest and value brought out. 3000 w. Brick—Oct. 1, 1903. Serial. 1st part. No. 58315.

Granite.

Tests upon Granite Blocks for Arch Hinges (Versuche mit Granitquadern zu Brückengelenken). C. Bach. Data and results of compression tests of granite, showing the wide variations due to weathering, etc. 7000 w. 3 plates. Zeitschr d Ver Deutscher Ing—Oct. 3, 1903. No. 58517 D.

Reinforced Concrete.

A Roof on the Melan System (Eine Ueberdachung nach Bauweise Melan). Illustrating and describing a flat arched roof of 18 metres span over a hall in Vienna. 1800 w. Beton u Eisen—4 Hefl, 1903. No. 58540 H.

Concrete Re-enforcement. Julius Kahn. Illustrates and describes a system of concrete re-enforcement designed to resist vertical shear, stating the principles of the type recommended. 2500 w. R R Gaz—Oct. 16, 1903. No. 58399.

Construction of a Well in Reinforced Concrete 20 Metres Deep (Erbauung eines 20 M. tiefen Brunnens aus Eisenbeton). L. Zöllner. Describing the sinking of a well 8 metres in diameter, 20 metres deep, lining it with reinforced concrete walls. 1000 w. Beton u Eisen—4 Heft, 1903 No. 58542 H.

Origin and Development of Armored Concrete. An account of a lawsuit in France concerning the Monier and Hennebique patents, and also the patents of other inventors. 800 w. Engr, Lond—Oct. 9, 1903. No. 58441 A.

Regulations in Regard to the Use of Concrete Steel. Issued by the Bureau of Buildings, Borough of Manhattan, New York. Also editorial. 2200 w. Eng Rec—Oct. 10, 1903. No. 58343.

The Determination of the Lines of Influence in a Beam Secured at One End and Free at the Other (Bestimmung der Einflusslinien eines Trägers welcher an dem ein Ende Eingeklemmt ist und aus anderen Ende Frei Aufliegt). Prof. Ramisch. A mathematical analysis for an overhung beam of reinforced concrete. 2500 w. Beton u Eisen—4 Heft, 1903. No. 58546 H.

The Eggert Ceiling (Eggert Decke). Describing a flat combination floor and ceiling in reinforced concrete, with data and illustrations of tests. 1500 w. Beton u Eisen—4 Heft, 1903. No. 58543 H.

The German Municipal Exposition in Dresden, 1903 (Die Deutsche Städte-Ausstellung in Dresden, 1903). H. Bastine. Giving illustrations of a variety of reinforced concrete structures erected on the exposition grounds. 2500 w. 1 plate. Beton u Eisen—4 Heft, 1903. No. 58544 H.

The Use of Reinforced Concrete Piles for the Foundation of the Berlin Court House (Die Gründung des Amtsgerichtsgebändes auf dem Wedding in Berlin mit Betoneisen pfählen). H. Hertel. Describing the construction of the piles and the method of sinking them. 3500 w. Beton u Eisen—4 Heft, 1903. No. 58545 H.

Water Conduits and Sewers in "Sidero-Cement" (Conduites d' Eau Egouts Cylindriques en "Sidero-Cement"). Describing large concrete mains with longitudinal and circumferential reinforcements of round rods and rolled sections. Serial, Part I. 2000 w. Beton u Eisen—4 Heft, 1903. No. 58541 H.

MEASUREMENT.

Current Meters.

Vertical and Inclined Current Meters (Der Normal und Schiefgestellte Hydrometriche Flügel). H. Lauda. An elaborate discussion of the calibration of current meters of the Woltmann mill type for measuring the flow of water in streams, showing the influence of position upon the readings. Two articles, 8000 w. Oesterr Wochenschr fd Oeff Baudienst—Sept. 19, 26, 1903. No. 58577 each D.

Surveying.

An Improved Mining Compass (Ein Neues Zulegzeug). O. Nowotny. Describing an improved instrument for running lines in mining work and especially adapted for convenient use underground. 1000 w. Oesterr Zeitschr f Berg u Huttenwesen—Sept. 19, 1903. No. 58550 D.

General Instructions to Locating Engineers. Issued by William Ashton, Resident Engineer, Oregon Short Line R. R. 1200 w. Eng Rec—Oct. 24, 1903. Serial. 1st part. No. 58630.

Topography.

Topographic Work in the Grand Canyon of the Gunnison. I. W. McConnell. An illustrated article giving facts brought out by surveys and explorations made to determine the possibility of diverting the water from the Gunnison River into the Uncompahgre Valley. 2500 w. Eng Rec—Oct. 3, 1903. No. 58260.

MUNICIPAL.

Garbage.

Baltimore's System of Garbage Disposal. Describes and illustrates a recently constructed plant having new features. 700 w. Sci Am—Oct. 31, 1903. No. 58681.

Lighting.

Costs and Prices of Gas and Electric Lighting by Municipal Plants. Alton D. Adams. Considers 18 cities and towns in Massachusetts. Also editorial. 3800 w. Munic Engng—Oct., 1903. No. 58233 C.

Park.

Revere Beach Reservation of the Metropolitan Park System, Boston. H. J. Kellaway. An illustrated article describing the improvements made at a Boston resort. 2000 w. Eng Rec—Oct. 24, 1903. No. 58625.

Pavements.

Some Observations on Street Pavements. S. Whinery. The present article gives statistics showing the importance from the financial standpoint, and the need of scientific study of the subject, suggesting the lines most profitable, and considering the endurance of pavements, construction, etc. 5500 w. Eng News—Oct. 22, 1903. Serial. 1st part. No. 58639.

The Six-Inch Macadam Streets of Hudson, N. Y. H. K. Bishop. An illustrated article giving an account of the street improvements and describing the method of doing the work, giving cost. Also letter and editorial bearing on this subject. 3300 w. Eng News—Oct. 8, 1903. No. 58352.

Pipe Galleries.

Pipe Gallery Experience. James C. Bayles. A summary of experience with pipe galleries in cities, showing their advantages. 3800 w. Dom Engng—Oct. 24, 1903. No. 58656 C.

Refuse.

The Disposal of New York's Refuse. An illustrated account of methods in use, with some references to past methods. 2300 w. Sci Am—Oct. 24, 1903. No. 58649.

Sewage.

A British View of the Bacterial Treatment of Sewage. Dr. Samuel Rideal. Abstract of a paper before the International Cong. of Hygiene at Brussels. Gives conclusions based on careful study. 1200 w. Eng News—Oct. 22, 1903. No. 58643.

Sewage Purification Plants for Summer Cottages. John W. Alvord. Shows how modern improvements in the septic tank can be adopted for summer resort cottages at small cost. Ill. 600 w. Sci Am Sup—Oct. 17, 1903. No. 58413.

The Design of Works for the Bacterial Treatment of Sewage. Stuart H. Davies. A discussion of the most important points in the design of works, with general consideration of the subject. 2700 w. Engng—Oct. 9, 1903. No. 58436 A.

Streets.

Difficult Street Intersections. An account of the plans used in Duluth, Minn., on steep grades. 2000 w. Eng Rec—Oct. 24, 1903. No. 58629.

WATER SUPPLY.

Analysis.

Field Methods of Water Analysis Adopted by the United States Geological Survey. An authorized statement obtained through the courtesy of Mr. F. H. Newell, Chief Engineer. 600 w. Eng News—Oct. 22, 1903. No. 58637.

The Significance of Bacteriological Methods in Sanitary Water Analysis. C. E. A. Winslow and C. P. Nibecker. Discusses the significance of chemical analysis and bacteriological examinations, describing tests and giving results of studies. 5000 w. Tech Qr—Sept., 1903. No. 58385 E.

Denver.

The Cheesman Dam and Other Works for the Water Supply of Denver, Colorado. An illustrated description of a masonry dam under construction. 4300 w Eng Rec—Oct. 24. 1903. No. 58624.

Ground Water.

Conservation and Increase of Subterrean Water. E. O. Mawson. Considers the means by which this source of water supply may be conserved and increased. 4300 w. Engr, Lond—Oct. 9, 1903. No. 58439 A.

Mains.

Moving a 48-in. Force Main Under Pressure, at Philadelphia. Seth M. Van Loan. Outlines the reasons why the undertaking was necessary, showing the conditions during the progress of the work, and describing the main features. 1000 w. Eng News—Oct. 8, 1903. No. 58354.

Meters.

The Methods and Cost of Installing Meters at Cleveland, O. Information from papers by Edward W. Bemis, and from the annual report. 1800 w. Eng News—Oct. 22, 1903. No. 58641.

New York City.

Progress Report of Commission on Additional Water Supply for New York City. The first report of the Commission setting forth the main conclusions reached, with editorial. 9200 w. Eng News—Oct. 1, 1903. No. 58184.

Quality.

Potable Waters in Southwest Lancashire. J. Campbell Brown. Considers the quality of the surface waters, deep wells and spring waters, giving results of analysis. 1500 w. Engng—Oct. 2, 1903. No. 58298 A.

The Supply of Towns with Potable Water (L' Alimentation des Villes en Eau Potable). F. Diénert. Discussing especially the causes of pollution and the best methods of purification, including various systems of filtration. 5000 w. Rev Gen des Sciences—Oct. 15, 1903. No. 58531 D.

Sand Washers.

Sand Washers at the Roxborough Filters, Philadelphia. Illustrates and describes interesting features introduced in these plants. 1500 w. Eng Rec—Oct. 10, 1903. No. 58342.

ELECTRICAL ENGINEERING

COMMUNICATION.

Automatic Systems.

The Home Telephone Company, Dayton, Ohio. An illustrated description of a large automatic exchange recently inaugurated. 2500 w. Elec Rev, N Y—Oct. 24, 1903. No. 58621.

The Prött Automatic Telephone System (Das Fernsprech Nebenstellensystem von Prött). Dr. K. G. Frank. Describing a variety of automatic telephony in which groups of subscribers are connected with each other from the central station. 3000 w. Elektrotech Zeitschr—Sept. 17, 1903. No. 58559 B.

Cables.

Laying the New Block Island Cable. Illustrated description of the work of laying eleven miles of heavy cable connecting Block Island with the mainland of Rhode Island. 1200 w. Elec Rev, N Y—Sept. 26, 1903. No. 58123.

Glasgow.

The Glasgow Municipal Telephone System. The first of a series of articles giving facts and figures on capital cost. 2200 w. Elec Rev, Lond—Oct. 9, 1903. Serial. 1st part. No. 58422 A.

Multiple System.

The Rowland Multiple Telegraph System (Uber den Rowlandschen Vielfachtelegraphen). H. Tuck. A fully illustrated account of the Rowland apparatus by which eight messages are sent simultaneously over a single wire. The system is in operation between Berlin and Hamburg. 10000 w. Elektrotech Zeitschr—Sept. 17, 1903. No. 58561 B.

Space Telegraphy.

De Forest System of Wireless Telegraphy. A. S. McLean. A brief illustrated explanation of this system and its operation. 1600 w. Yale Sci M—Oct., 1903. No. 58475 C.

Experiments on Selective Wireless Telegraphy. Anders Bull. An account of recent tests made of the author's system. 1200 w. Elect'n, Lond—Oct. 2, 1903. No. 58283 A.

The Kamm Typewriter for Use with Wireless Telegraphy. Illustrates and describes this ingenious instrument used for transmitting or receiving messages, explaining the *modus operandi.* 1800 w. Sci Am—Oct. 17, 1903. No. 58406.

The Present Status of Wireless Telegraphy (L'Etat Actuel de la Télégraphie sans Fil). C. Tissot. A general review of the fundamental principles involved in magnetic space telegraphy and a description of the detailed devices actually in use. 7000 w. Rev Gen des Sciences—Oct. 15, 1903. No. 58530 D.

The Snow Wireless Telegraph System. Dr. Louis Duncan. An account of the fundamental principles of this system. 1800 w. Elec Wld & Engr—Oct. 24, 1903. No. 58659.

The Stone Wireless Telegraph System. An illustrated article describing Mr. Stone's work in selective wireless telegraphy. 2200 w. Elec Rev, N Y—Oct. 24, 1903. No. 58623.

The Wireless Protocol. Text of the final protocol of the international wireless telegraph conference. 600 w. Sci Am Sup—Oct. 10, 1903. No. 58372.

Switchboards.

Alternating Current Switchboards. Stephen Q. Hayes. The first of a series of articles giving illustrated descriptions of boards made by the Westinghouse Company. 1600 w. Elec Wld & Engr—Sept. 26, 1903. Serial. 1st part. No. 58125.

Telegraphone.

The New Telegraphone. An illustrated description of recent improvements made in the Poulsen invention. 900 w. Sci Am—Oct. 3 1903. No. 58173.

The Telephone and the Railway. Brief account of recent tests made on a number of American railways with the telegraphone. 1000 w. Sci Am—Oct. 24, 1903. No. 58647.

Telephone Cables.

Cable Tests and Specifications. H. J. Dommerque. Discusses the electrical requirements of a telephone cable when in service, indicating methods of testing and making up specifications. 3300 w. Am Elect'n—Oct., 1903. No. 58360.

The Efficiency of Telephone Cables with Uniformly Divided Self-Induction (Ueber die Leistungsfähigkeit von Fernsprechkabeln mit Stetig Verteilter Selbstinduktion). F. Dolezalek & A. Ebeling. A theoretical and practical study of the action of the Pupin coils upon the performance of telephone lines. 5000 w. Elektrotech Zeitschr—Sept. 17, 1903. No. 58560 B.

Telephony.

How the Telephone Operator Assists the Electrician. Arthur B. Weeks. A description of the work of the telephone operator and electrician on emergencies. 1800 w. St Ry Rev—Sept. 20, 1903. No. 58129 C.

Independent Telephony in Great Britain. The first of a series of articles on the construction, capital cost and managements of exchanges in England. 2000 w. Elec Engr, Lond—Oct. 2, 1903. Serial. 1st part. No. 58279 A.

Portsmouth Corporation Telephones. Explains the commercial policy of the undertaking and illustrates and describes the equipment. 2500 w. Elec Engr, Lond—Oct. 9, 1903. No. 58420 A.

Two-Wire Intercommunicating Telephone Systems. H. S. Webb. Explains what is meant by the title and describes the system, illustrating with diagrams. 1800 w. Am Elect'n—Oct., 1903. No. 58364.

DISTRIBUTION.

Booster.

A Simple Alternating Current Booster. F. B. O'Hanlon. Explains the principle on which these boosters are designed. 3500 w. Am Elect'n—Oct., 1903. No. 58359.

Current Conversion.

Continuous Currents from Alternating Supply Mains (Gleichstrom aus Wechselstromnetzen). K. Sterzel. Describing a form of apparatus for deriving a pulsating current of constant direction from an alternating circuit. The flow is equalized by a storage battery. 2500 w. Elektrotech Zeitschr—Oct. 8, 1903. No. 58566 B.

Motor Generators and Rotary Converters. H. M. Hobart. Examines the properties of these two types of apparatus, favoring the use of motor generators because of their superiority in convenience of operation. 1500 w. Elec Rev, Lond—Sept. 25, 1903. Serial. 1st part. No. 58201 A.

Lost-Current.

Lost and Unaccounted for Current. L. G. Van Ness. Classifies the losses under both alternating and direct systems, endeavoring to show that they may be accounted for and suggests means of reducing the loss. 2200 w. Cent Sta—Oct., 1903. No. 58314.

Mains.

Trouble Prevention on Electric Mains. J. H. C. Brooking. Considers details needing attention and gives hints of use to central station engineers. 1800 w. Feilden's Mag—Oct., 1903. No. 58472 B.

Motor-Generators.

The Motor Generator Sets of the Stockholm Electric Station (Motor Generator Gruppen des Elektrizitätswerkes Stockholm). A description of the 500 kw motor-generator converters built by the Oerlikon works with data and results of tests. 3000 w. Schweiz Bauzeitung—Oct. 3, 1903. No. 58557 B.

Resistance Switch.

Liquid Resistance Switch. Illustrated description of a new form of liquid resistance switch, which combines a circuit-breaking and direction-reversing arrangement with a regulating resistance. 800 w. Engr, Lond—Oct. 9, 1903. No. 58443 A.

ELECTRO-CHEMISTRY.

Accumulators.

Total and Free Energy of the Lead Accumulator. R. A. Lehfeldt. Read before the Faraday Soc. An analysis of the transformations of energy. 3000 w. Electro-Chem & Met—Sept., 1903. No. 58234 E.

Arsenic Detection.

The Electrolytic Estimation of Minute Quantities of Arsenic, More Especially in Brewing Materials. T. E. Thorpe. Illustrated description of apparatus and methods. 4000 w. Electro-Chem & Met —Sept., 1903. No. 58236 E.

Electrolysis.

The Present Position of the Theory of Electrolysis. W. C. Dampier-Whetham. Read before the Faraday Society. Reviews the investigations made to explain the phenomena of electrolysis, and the results thus far established. 7000 w. Elect'n, Lond—Oct. 9, 1903. No. 58424 A.

Metals.

Chemical Valency, Electrical Conductivity and Hardness of Metals. John G. A. Rhodin. A study of the conductivity of metals from an electro-chemical standpoint. 2500 w. Electro-Chem & Met—Sept., 1903. No. 58235 E.

Primary Battery.

A Simple and Economical High-Voltage Battery. Charles J. Sullivan. Illustrates and describes an outfit which requires care for only five gravity cells. 800 w. Sci Am Sup—Oct. 24, 1903. No. 58650.

ELECTRO-PHYSICS.

Electron Theory.

A Theory of Ons: In Reconciliation of the Undulatory Theory of Electricity with Ionization and the Electron Hypothesis. R. R. Bowker. Presents an hypothesis for the consideration of investigators. Also editorial. 2800 w. Elec Wld & Engr—Sept. 26, 1903. No. 58124.

Electrostatic Transformers.

On an Attempt to Construct an Electrostatic Transformer. James Edmund Ives. Describes some experiments with a ballistic galvanometer, and others with the alternating-current. 800 w. Elec Wld & Engr—Oct. 10, 1903. No. 58339.

Losses.

Iron Loss. An explanation of the great difference between the iron loss in dynamos and in transformers. 2200 w. Elect'n, Lond—Oct. 16, 1903. No. 58499 A.

Maximum Current.

A Proof of the Law for Grouping Cells to Obtain Maximum Current. E Dana Pierce. Gives an algebraic proof which is mathematically complete and capable of being understood by any one familiar with simple algebra. 500 w. Elec Wld & Engr—Oct. 3, 1903. No. 58253.

Radio-Activity.

Radio-Activity. Editorial review of the recent paper by Prof. Rutherford and Mr. Soddy, and the work of other experimenters. 2500 w. Engng—Sept. 25, 1903. No. 58209 A.

Radio-Activity. The Secret of Radium's Light and Heat. Hudson Maxim. Explains the writer's theory. 2000 w. Sci Am Sup—Oct. 3, 1903. No 58178.

The Stereoscopic Radioscope (La Radioscopie Stérescopique). Describing the Villard apparatus, using a Ruhmkorff coil and stroboscope for obtaining stereoscopic effects. 1800 w. Génie Civil—Oct. 3, 1903. No. 58506 D.

Speed of X-Rays Determined by M. Blondlot. C. L. Durand. Gives a method proving that the x-rays are propagated with the same velocity as those of light. 1800 w. Elec Rev, N Y—Oct. 17, 1903. No. 58452.

GENERATING STATIONS.

Armatures.

The Reaction of Alternator Armatures (Réaction d' Induit des Alternateurs). C. F. Guilbert. A study of the counter electro-motive force of the armature, using both analytical and graphical methods. Two articles. 4500 w. Revue Technique—Sept. 25, Oct. 10, 1903. No. 58507 each D.

Auxiliary Plant.

Central Station Auxiliary Plant. Francis H. Davies. A detailed discussion of pumps, injectors, stoking and economizer gear, etc. 2300 w. Elec Rev, Lond—Sept. 25, 1903. No. 58200 A.

Dublin.

Electricity Supply in Dublin. Reviews the history of the Dublin works, explaining the backward condition of electricity supply matters, and begins an illustrated description of the new works just completed, at Pigeon House Fort. 2200 w. Elect'n, Lond—Sept. 25, 1903. Serial. 1st part. No. 58202 A.

Dynamo Design.

The Influence of Rotative Speed upon the Design of Continuous-Current Dynamos (Der Einfluss der Tourenzahl auf der Entwurf von Gleichstrommaschinen). H. M. Hobart. Considering especially the design of very high speed generators, such as are adapted to be driven by steam turbines. 5000 w. Elektrotech Zeitschr—Oct. 1, 1903. No. 58564 B.

The Modern Construction of Electric Machinery (Moderne Konstruktionen in Elektro-Maschinenbau). A. Tischbein. With especial reference to correct proportions, including the use of ball bearings. Serial, Part I. 3000 w. Glasers Annalen—Sept. 15, 1903. No. 58522 D.

Electrical Machinery.

Electric Light and Power Engineering. This first paper is a description of the construction and action of dynamos. 3700 w. Mech Engr—Oct. 10, 1903. Serial. 1st part. No. 58419 A.

Exposition Plant.

The 60,000 Horse-Power Plant at the World's Fair. Godfrey L. Carden. Information of interest in regard to the power plant and the work it is to do. 1300 w. Sci Am—Oct. 3, 1903. No. 58170.

Fitchburg.

Electrical Supply in Fitchburg. Illustrates and describes the generating station of the Fitchburg (Mass.) Gas & Electric Light Co., giving interesting features of the city as well. 2200 w. Elec Wld & Engr—Oct. 3, 1903. No. 58251.

Gas Power.

Gas-Driven Electric-Light Plant at Tunis. Illustrations with brief description of a plant in which producers' gas and gas engines furnish the motive power. 500 w. Engng—Sept. 25, 1903. No. 58206 A.

Heyland Generators.

On the Compensation and Compounding of Alternating-Current Generators. H. S. Meyer. Remarks on the generators of the Heyland type. 1500 w. Elect'n, Lond—Oct. 16, 1903. No. 58498 A.

dro-Electric.

Transmission of Hudson River Power. An illustrated description of the Spier Falls power development. 3000 w. Elec Wld & Engr—Oct. 24, 1903. No. 58657.

Isolated Plant.

Electrical Equipment of a Grain Elevator. C. W. Whitney. An illustrated description of the power plant of the Southern Pacific Terminal Co., at Galveston, Texas. 1500 w. Am Elect'n—Oct., 1903. No. 58358.

Electrical Equipment of an Industrial Plant. An illustrated description of the power and lighting plant of the Grand Union Tea Co., at Brooklyn, N. Y. 2500 w. Am Elect'n—Oct., 1903. No. 58361.

Mining Plant.

Polyphase Electric Plant at the Staveley Coal and Iron Company's Collieries. An illustrated detailed description of this plant recently installed in English mines. 3200 w. Ir & Coal Trds Rev—Sept. 25, 1903. No. 58218 A.

Parallel Runnning.

The Parallel Working of Alternators. B. Hopkinson. Read at Southport meeting of the British Assn. An attempt to harmonize the mathematical treatment with the practical rules regarded as good practice. 5000 w. Elec Engr, Lond—Sept. 25, 1903. No. 58197 A.

Polyphase.

Improved Compound Polyphase Generator (Neuer Compound-Drehstrom-Generator). E. Kolben. Describing a modification of the Heyland machine with especial reference to the commutator construction. 2500 w. Elektrotech Zeitschr—Oct. 8, 1903. No. 58567 B.

Synchronism.

Synchronising Devices. F. H. Davies. Describes the earliest method used, and some recent devices, commenting on their efficiency. 1800 w. Elec Engr, Lond—Oct. 2, 1903. No. 58280 A.

Vienna.

The Municipal Electric Stations in Vienna (Die Städtischen Elektrizitätswerke in Wien). Gustav Klose. A very full illustrated account of the large generating stations at Vienna furnishing current for tramways, lighting and power. Three articles. 10000 w. Zeitschr d Oesterr Ingr Arch Ver—Sept. 25, Oct. 2, 9, 1903. No. 58533 each D.

LIGHTING.

Arc Lamps.

Construction of a Direct-Current Enclosed Arc Lamp. Illustrated detailed description. 2000 w. Am Elect'n—Oct., 1903. No. 58362.

The Development of Arc Lamps. William Mayo Venable. Reviews briefly the development of both the open arc and the enclosed arc, with remarks on the direction of future improvements. 2500 w. Elec, N Y—Sept. 30, 1903. No. 58141.

Department Store.

A Notable Example of Central Station Supply of Electric Power and Light. Describes the installation in Marshall Field & Co.'s stores, in Chicago. 2200 w. Eng Rec—Sept. 26, 1903. No. 58137.

Exposition.

The Electric Light and Power Situation in St. Louis. An illustrated article reviewing the past history and present condition of the electric light and power business and outlining the future policy. 4200 w. Elec Wld & Engr—Oct. 17, 1903. No. 58460.

Illumination.

The Illumination of the Future. E. Leavenworth Elliott. Reviews briefly the progress of artificial illumination as the basis of a forecast of future development. Thinks the most probable improvement will be the use of incandescent gas as the light radiator. 1500 w. Cent Sta—Oct., 1903. No. 58313.

Nernst Lamp.

Photometric Tests of the Nernst Lamp. From the fourth progress report of the N. E. L. A. Committee for Investigating the Photometric Values of Arc Lamps. 1500 w. Elec Wld & Engr—Oct. 24, 1903. No. 58659.

See also Civil Engineering, Municipal.

MEASUREMENT.

Ammeter.

A Graphic Recording Ammeter. A. H. Armstrong. Illustrates and describes this instrument. 1000 w. Trans Am Inst of Elec Engrs—Oct., 1903. No. 58619 D.

Armature Testing.

Armature Testing with a Milli-Voltmeter. Cale Gough. On the use of the milli-voltmeter for finding defects, the method of testing, etc. 1800 w. St Ry Jour—Oct. 3, 1903. No. 58247 C.

Conductivity.

The Conductometer. Illustrates and describes a direct reading conductivity meter devised by Rollo Appleyard. 1500 w. Elec Rev, Lond—Oct. 9, 1903. No. 58423 A.

Galvanometers.

Consideration of Some Points in the Design and Working of Ballistic Galvanometers. P. H. Powell. Read at the Southport meeting of the British Assn. Gives an illustrated outline of the design of one of these instruments. 1200 w. Elec Rev, Lond—Sept. 25, 1903. No. 58199 A.

Insulation.

A Method for Determining the Electrical Resistance of High Insulating Substances (Ein Verfahren zur Bestimmung der Elektrischen Durchschlagsfestigkeit Hochisolierender Substanzen). Dr. B. Walter. Discussing the breaking-down resistance of glass, hard rubber and similar substances, with data and results of experiments. 10000 w. Elektrotech Zeitschr—Sept. 24, 1903. No. 58562 B.

Power Measurement

The Measurement of Power in Alternating-Current Circuits. F. W. Ballard. Abstract of a lecture before the United Assn. of Sta. Engrs. of Cleveland Description of methods employed. 3300 w. Engr, U S A—Oct. 1, 1903. No. 58242 C.

Three-Phase Power Measurements. F. Hardie Jeannin. Describes a graphical method for computing the power in any three-phase system with no other data than the three ammeter and voltmeter readings. Also editorial notes. 4500 w. Elec Wld & Engr—Oct. 10, 1903. No. 58340.

Resistance.

An Improved Graphite Resistance (Ein Neuer Graphitwiderstand). R. Hopfell. The graphite is used in the form of powder compressed in cylindrical cases. 1500 w. Elektrotech Zeitschr—Oct. 8, 1903. No. 58568 B.

Rheostats.

Rheostats for Dynamo Load Tests. Brief illustrated description of how to make a simple form of water rheostat. 1000 w. •Am Elect'n—Oct., 1903. No. 58363.

Standards.

Experiments for Improving the Construction of Practical Standards for Electrical Measurements. Report of a committee of the British Association, presented at Southport. 4000 w. Elect'n, Lond—Oct. 2, 1903. No. 58284 A.

Transformers.

Measuring Instrument Transformers. F. Punga. Explains the use of transformers in connection with measuring instruments to measure currents, showing the influence of various factors on the ratio of primary to secondary currents. Ill. 2500 w. Elect'n, Lond—Oct. 9, 1903. No. 58425 A.

POWER APPLICATIONS.

Air Compressors.

Electrically Driven Air Compressors (Elektrisch Betriebene Luftkompressoren). A fully illustrated account of the application of electric driving to various forms of air compressors, with especial reference to their use in mining work. Two articles. 1 plate. 4000 w. Glückauf —Oct. 3, 10, 1903. No. 58549 each D.

Department Store.

See Electrical Engineering, Lighting.

Electrical Energy.

On the Mechanism of Electric Power Transmission. Dr. A. E. Kennelly. Considers Hertzian as well as alternating and direct-current transmission, illustrating by example the application of the principles. 2500 w. Elec Wld & Engr—Oct. 24, 1903. No. 58658.

Elevators.

The Arrangement of Controllers for Electric Elevators (Die Elemente des Druckknopfsteuerungen für Elektrische Aufzüge). Dr. K. Kahle. Discussing especially the connections for controlling electric elevators by means of push buttons on the various floors. 7000 w. Elektrotech Zeitschr—Sept. 17, 1903. No. 58558 B.

Factories.

Purchased Electric Power in Factories. E. W. Lloyd. Abstract of a paper read before the Assn. of Edison Ill. Cos. Considers the installation of motors, and the cost of power from central stations for large factories, as compared with isolated plant costs. 3200 w. Elec Wld & Engr—Sept. 26, 1903. No. 58127.

Induction Motors.

Management of Induction Motors. George T. Hanchett. Describes the behavior of the induction motor, and shows why it is often objectionable. 2500 w. Cent Sta—Oct., 1903. No. 58312.

Repulsion Motors.

On Single-Phase Repulsion Motors. William Cramp. Read at Southport meeting of the British Assn. A study of the design of the repulsion motor. Ill. 4000 w. Elec Engr, Lond—Sept. 25, 1903. Serial. 1st part. No. 58198 A.

Speed Variation.

A Possible Source for Securing Wide Speed Range in Direct-Current Motors. Albert F. Hemingway. Describes methods that have been tried, especially the design of E. Lanhoffe, and the type conceived by the author. 2400 w. Elec Wld & Engr—Oct. 3, 1903. No. 58254.

Starters.

Graphical Proportioning of Starters (Zeichnerische Bestimmung von Anlassern). Rudolf Krause. Deriving diagrams for use in designing starters for motors of various types and speeds. 1500 w. Zeitschr f Elektrotechnik—Oct. 4, 1903. No. 58570 D.

TRANSMISSION.

Arresters.

Lightning Arresters on Transmission Lines. Alton D. Adams. Considers the dangers from atmospheric electricity, the true purpose of lightning arresters, the types in use, the most recent practice, the degree of security, etc. 4500 w. Elec Rev, N. Y.—Oct. 10, 1903. No. 58337.

Circuit Breakers.

Reverse Current Circuit Breakers and the Protection of Transmission Lines. Leonard Wilson. Considers this system of protection, discussing its more important characteristics, and the essential feature of the Andrews system. 2200 w. Trans Am Inst of Elec Engrs—June, 1903. No. 58618 D.

Line.

Overhead Pole Line Construction and Operation for Central Stations. A. H. Manwaring and J. T. Hutchings. Read at meeting of the Assn. of Edison Ill. Co.'s. Treats of important points to be considered in successful pole line construction for a plant supplying current for series arc lighting and alternating current for light and power. 4000 w. Elec Wld & Engr—Sept. 26, 1903. No. 58126.

Mining Transmission.

Relative Advantage of 2,300-Volt Alternating Current versus 550-Volt Direct Current, for Mine and Smelter Work. Hugh A. Brown. States the advantages of each. 1500 w. Eng & Min Jour—Sept. 26, 1903. No. 58135.

Protection.

Protective Devices for High-Tension Electrical Systems. W. B. Woodhouse. Read before the British Assn. An illustrated article discussing points in connection with the operation of a high-tension polyphase transmission system. 2800 w. Elect'n, Lond—Sept. 25, 1903. No. 58203 A.

Three-Phase.

On Three-Phase Switch Gear. A. C. Eborall. An illustrated article, giving the writer's reasons for not favoring the cellular and backless type of switchboard in connection with high-pressure symptoms, aud outlining the lines upon which such switchboards should be constructed. 5500 w. Engng—Sept. 25, 1903. Serial. 1st part. No. 58205 A.

The First Transmission of Energy in Europe by Means of Triphase Currents. Emile Guarini. Illustrated description of the Hochfeld-Glattfeld-Oerlikon line. 2000 w. Sci Am Sup—Oct. 17, 1903. No. 58411.

Wire Stresses.

Computation of Sag and Stress in Freely Suspended Wires (Berechnung des Durchhanges und der Spannung in Frei Gespannten Drähten). A. Sengel. Developing equations for the determination of the catenary for overhead wires. 2500 w. Elektrotech Zeitschr—Sept. 24, 1903. No. 58563 B.

GAS WORKS ENGINEERING

Acetylene.

The Generation of Acetylene. J. M. Morehead. Considers the points of danger, and claims that the generators now used, if operated according to instruction, are safe. 2700 w. Elec-Chem Ind—Oct., 1903. No. 58322 C.

Cannel Coal.

Boghead Cannel. A copy of a report of this coal made in 1850 in regard to its value for the production of gas. 1500 w. Gas Wld—Oct. 17, 1903. No. 58490 A.

Coal Tar.

The Distillation of Coal Tar. Harold Smith. Read before the Manchester & Dist. Jr. Gas Assn. A description of the process involved in the extraction of the crude products, mentioning their principal uses. Discussion. 3600 w. Jour Gas Lgt —Sept. 29, 1903. No. 58270 A.

Gas Works.

Steel Building Construction in Gas-Works. Samuel Cutler, Jr. Read before the Eastern Co.'s Gas Mgrs.' Assn. An illustrated article considering particularly buildings for inclined retort-benches and carburetted water-gas plants, giving brief descriptions of examples. General discussion. 8000 w. Jour Gas Lgt—Sept. 22, 1903. No. 58194 A.

Inclined Retorts.

The Home of the Inclined Retort in England. An illustrated article describing the past and present systems of the Brentford Gas Co. at Southall, England. 4000 w. Jour Gas Lgt—Sept. 29, 1903. No. 58269 A.

Lighthouses.

Acetylene Gas in the Chassiron Lighthouse. An illustrated description of experiments being carried out in France which greatly increase the illuminating power. 1800 w. Engng—Oct. 16, 1903. No. 58476 A.

Use of the Incandescent Mantle in Lighthouses. Illustrates and describes the incandescent arrangements in use in France. 1000 w. Sci Am Sup—Oct. 17, 1903. No. 58412.

Mantles.

The Action of the Incandescent Mantle in the Flame. Epitome of a long communication by Dr. C. Killing, to a recent number of the *Journal für Gasbeleuchtung*, on the theoretical basis of incandescent gas lighting. 1400 w. Jour of Gas Lgt —Oct. 13, 1903. No. 58493 A.

Photometer.

A Development of the Simmance-Abady "Flicker" Photometer. Illustrates and describes a modification presenting a wider range of utility than the original form. 1500 w. Jour Gas Lgt—Oct. 6, 1903. No. 58378 A.

Purification.

A Simplified Method of Gas Purification to Completely Recover Tar and Ammonia. Abstract translation of a short paper by Herr Burgemeister at the meeting of the German Assn. of Gas & Water Engrs. Ill. 1300 w. Jour of Gas Lgt—Oct. 13, 1903. No. 58492 A.

Train Lighting.

See Railway Engineering, Motive Power and Equipment.

Tynemouth.

Constructional Details and Costs of Recent Extensions (1900-1902), with Notes on Working Results, at the Tynemouth Gas-Works, North Shields. A. Clement Hovey. Read before the North of Eng. Gas Mgrs.' Assn. Ill. 12500 w. Jour Gas Lgt—Oct. 6, 1903. No. 58380 A.

See also Civil Engineering, Municipal.

INDUSTRIAL ECONOMY

Apprentices.

Engineering Apprentices. D. B. Morison. Outlines a scheme for the advancement of apprentices to be given a trial at the Hartlepool Engine Works. Also editorial. 2400 w. Engng—Sept. 25, 1903. No. 58208 A.

The Apprenticeship Question. John E. Sweet. Read before the Mutual Trades Assn. of Syracuse, N. Y. Remarks on the changed conditions and the necessity of providing proper instruction for American boys who wish to become mechanics, suggesting ways. 2800 w. Am Mach—Oct. 22, 1903. No. 58615.

Coal Syndicate.

The Reconstruction of the Westphalian Coal Syndicate. Discusses the project for the reconstruction and the chief points of the new agreement. 2200 w. Ir & Coal Trds Rev—Oct. 9, 1903. No. 58429 A.

Education.

Commercial and Industrial Education in England. Discusses the neglect of commercial and technical training until recently, and what is now being done. 2500 w. U S Cons Repts. No 1786—Oct 28, 1903. No. 58631 D.

English Industry and Advanced Technical Education. Prof. H. I. Hannover. Extract from paper read before the Danish Inst. of Engrs. Impressions from a visit to English factories and colleges. 8000 w. Engng—Oct. 16, 1903. No. 58480 A.

Functions of Technical Science in Education for Business and the Professions. Robert H. Thurston. An address at the dedication of Engng. Hall, Iowa State College. 8000 w. Sci Am Sup—Oct. 24, 31, 1903. Serial. 2 parts. No. 58651.

Report upon Engineering Education. Elmer L. Corthell. A digest of information gathered during an extended tour, and years of study, giving present methods of teaching engineering in various countries, and comparing with similiar schools in the United States, with recommendations. 23800 w. Tech Qr—Sept., 1903. No. 58384 E.

Technical Education, What it Should be. Dr. Louis Duncan. A discussion of the relation of technical education to commercial and industrial progress. Also editorial comment. 3000 w. Engineering Magazine—Nov., 1903. No. 58581 B.

Erie Canal.

See Civil Engineering, Canals, Rivers and Harbors.

Exposition.

Some of the Engineering Features of the Louisiana Purchase Exposition, St. Louis, 1904. An illustrated article, giving general topographic plan of the grounds. The present number explains the character of the exposition, the civil engineering methods, river improvement, transportation, &c. 3000 w. Eng Rec—Oct. 3, 1903. Serial. 1st part. No. 58262.

Labor.

The Attitude of Trades Unions Toward Trade Schools. William H. Sayward. Why they do not look with favor on these schools, with a consideration of trade school conditions in various countries. 4000 w. Am Gas Lgt Jour—Oct. 12, 1903. No. 58321.

Steel Trade.

The United States Steel Corporation and the Outlook for the Steel Trade. Briefly reviews the development of the trust movement, methods, formation, &c., the danger that beset the U. S. Steel Corporation, and considerations favoring the combination. 4000 w. Ir & Coal Trds Rev—Oct. 2, 1903. No. 58308 A.

Works Management.

The Ethics of Workshop Management. Egbert P. Watson. A discussion of actual working relations between employers and men in the shop, based on extended experience. 2000 w. Engineering Magazine —Nov., 1903. No. 58587 B.

MARINE AND NAVAL ENGINEERING

Battleships.

The Latest Battleships for the United States Navy. Illustration, with brief description of the design of the "Louisiana" class. 900 w. Sci Am—Oct. 17, 1903. No. 58407.

Cruiser.

Some New Warships. Illustrated descriptions of the Hampshire, a cruiser of the Devonshire class, and the new Turkish cruiser "Abdul Hamid." Also briefly notices other vessels. 900 w. Engr, Lond —Oct. 2, 1903. No. 58301 A.

Cunard Contract.

The New Cunard Steamship Contract. Eugene Tyler Chamberlain. Considers this contract, and the agreement of the British Government with the International Marine Assn., and the effect on the future of American shipping. 4500 w. N Am Rev—Oct., 1903. No. 58287 D.

Ferryboats.

San Francisco Bay Ferryboats, San Jose and Yerba Buena. Illustrates and describes new boats of the double-screw type. 900 w. Naut Gaz—Oct. 15, 1903. No 58383.

San Francisco Bay Ferryboats, San Jose and Yerba Buena. Illustrates and describes the machinery of these boats designed for fast service. 2000 w. Naut Gaz—Oct. 22, 1903. No. 58608.

Japan

The Growing Naval Power of Japan. Archibald S. Hurd. An interesting account of the development of the navy, and the people who control the vessels. 3300 w. N Am Rev—Oct., 1903. No. 58288 D.

Launches.

Power Launches. An illustrated article giving general information of the material used, the construction, dimensions, &c. 2500 w. Naut Gaz—Sept. 24, 1903. No 58115.

Lubrication.

Internal Lubrication of Marine Machinery. H. C. Duryea. Considers remedies to secure as nearly as possible, the desired conditions. 2000 w. Marine Engng—Oct., 1903. No. 58143 C.

Mold Work.

Practical Mold Work in Shipyards. Sidney H. McLane. On the advantages of mold work, illustrating by example. 1500 w. Marine Engng—Oct., 1903. No. 58146 C.

Old Navy.

Ships of the Old Navy. Illustrates types of naval construction prevailing during the first three-quarters of the past century, giving a summary of their careers. 2000 w. Marine Engng—Oct., 1903. No. 58144 C.

Rivet Spacing.

Rivet Spacing in Merchant Vessels Classed at Lloyds. Gives a classification based on the best practice. 1200 w. Fielden's Mag—Oct., 1903. No. 58473 B.

Salvage.

Salvage of the German Steamer Muenchen. Translated from *Marine Rund-Schau*. An account of the grounding of a steamer on one of the Caroline Islands and the work of salvage under trying conditions. Ill. 3300 w. Naut Gaz—Oct. 8, 1903. No. 58310.

Steamships.

New Steamer Asbury Park, for the New York-Sandy Hook Route. An illustrated detailed description of this steamer and its equipment. 2200 w. Marine Engng—Oct., 1903. No. 58142 C.

Steamship Carpathia. Illustrates and describes this new vessel of the Cunard Line. 1000 w. Marine Engng—Oct., 1903. No. 58145 C.

The Steamship Kaiser Wilhelm II. (Le Paquebot Kaiser Wilhelm II. J. Bousquet.) A general illustrated description of the German transatlantic steamship, showing the construction and interior finishing. Serial. Part I. 3000 w. Génie Civil—Oct. 3, 1903. No. 58504 D.

Workshop.

A Floating Workshop. Illustrations, with brief description of a vessel recently completed for Durban Harbor. 500 w. Engr, Lond—Sept. 25, 1903. No. 58212 A.

MECHANICAL ENGINEERING

Construction.

Automobile Construction. Hugh Dolnar. The first article is introductory to a series describing methods and construction routine. 700 w. Am Mach—Oct. 8, 1903. No. 58390.

Developments in Automobile Construction. T. Clarkson. Especially considers vehicles weighing from half a ton to two tons, the working conditions of commercial automobilism, &c. 3000 w. Engr, Lond—Sept. 25, 1903. Serial. 1st part. No. 58217 A.

Electric Truck.

Coal Delivery in New York by an Electric Truck. Illustrates a vehicle in use in New York and vicinity, describing its working. 1000 w. Automobile—Oct. 10, 1903. No. 58320.

Gasoline Cabs.

London's Gasoline-Propelled Cabs. Illustration with brief description. 600 w. Sci Am—Oct. 3, 1903. No. 58172.

Gasoline Motor.

The Latest Applications of the Gasoline Automobile Motor. Illustrates its application to a railway inspection car, and also to a light delivery wagon. 500 w. Sci Am—Oct. 17, 1903. No. 58410.

Ignition.

A Simplification in Electric Ignition. Illustrated description of the system of high-tension ignition designed by Mr. Budge. 800 w. Autocar—Oct. 10, 1903. No. 58416 A.

Lamps.

Automobile Lamps. Illustrations of 20 styles, with brief descriptions. 3000 w. Automobile—Sept. 26, 1903. No. 58163.

Legislation.

British Motor-Car Act. Abstracts of an editorial in the Birmingham *Daily Post*, giving an idea of the scope and intentions of the act. 1500 w. U S Cons Repts, No. 1774—Oct. 14, 1903. No. 58366 D.

Lurries.

The Thornycroft Self-Propelled Lurries. Illustrates and describes a lurry driven by an internal combustion engine using petroleum. Also record of mileage. 1200 w. Auto Jour—Oct 17, 1903. No. 58601 A.

Mixed System.

A New Type of Gasoline-Electric Automobiles with Hub Motors. Illustrated description of new vehicles of the Lohner-Porsche firm. 1800 w. Sci Am Sup—Oct. 24, 1903. No. 58653.

Petrol-Electric Automobiles—The Mixed System. J. Sutherland Warner. The present article describes the advantages and disadvantages of the petrol car and also of the electric vehicle, as introductory to a description of a combined system. 1800 w. Elec Times—Oct. 1, 1903. Serial. 1st part. No. 58271 A.

Motor Bicycle.

The Starley Motor Bicycle. An illustrated description of a motor bicycle having many interesting features. 1800 w. Auto Jour—Oct. 10, 1903. No. 58417 A.

Motor Transport.

Motor Transport for Goods. Douglas Mackenzie. A report of the present condition of this field in England. 3800 w. Prac Engr—Oct. 16, 1903. Serial. 1st part. No. 58494 A.

Motor Vehicles.

Mechanical Road Vehicles. W. Worby Beaumont. A review of the achievements in this field, especially since 1896. 6400 w. Jour Soc of Arts—Oct. 16, 1903. Serial. Part I. No. 58654.

Motor Wagons.

Automobiles for Industrial Service (Motorfahrzenge für Nutzzwecke). Illustrated descriptions of Daimler vehicles for conveying merchandise, also description of the Daimler military wagon constructed for the German army. 1200 w. 1 plate. Zeitschr d Ver Deutscher Ing—Sept. 19, 1903. No. 58512 D.

Petrol Cars.

The Cadillac Petrol Car. Begins an illustrated detailed description of a car of moderate power and cost. 1300 w. Auto Jour—Oct. 17, 1903. Serial. 1st part. No. 58600 A.

Review.

Automobilism in 1903 (L' Automobilisme en 1903.) Gérard Lavergne. A review of automobile affairs in France during the current year, including the meetings, exhibitions, etc., and an account of improvements in details of vehicle and motor construction. 4000 w. Rev Gen des Sciences—Sept. 30, 1903. No. 58529 D.

Road Locomotive.

An Early Road Locomotive. Illustration, with historical account and description of a machine made about 1784. 1200 w. Sci Am—Oct. 17, 1903. No. 58409.

Steam Vehicles.

Steam Waggons for Commercial Use. R. G. L. Markham. A discussion of present practice, and use of these vehicles, especially considering those made in Great Britain. 3300 w. Cassier's Mag—Oct., 1903. No. 58691 B.

Traction.

The Resistance of Road Vehicles to Traction. Report of a committee submitted to the British Assn. Gives results of trials, suggestions, abstracts of papers, &c. 5800 w. Engng—Sept. 25, 1903. No. 58211 A.

Trials.

The Motor Car Trials. A review of the cost of these trials, giving particulars. 1700 w. Engr, Lond—Oct. 2, 1903. No 58304 A.

The Motor Car Trials. Review of the recent 1000 miles reliability trials organized by the British Automobile Club. 3000 w. Engr, Lond—Sept. 25, 1903. No. 58213 A.

The 1903 Reliability Trials from a Technical Point of View. Considers the present state of the automobile industry, and compares the merits of the different cars. Deals first with the petrol engines, showing how they compare for size and output. 2000 w. Auto Jour—Oct. 10, 1903. Serial. 1st part. No. 58418 A.

Tyres.

Tyres in the 1,000 Miles Trials. Gives details of their behavior, as furnished by the competitors. Ill. 1800 w. Autocar—Oct. 17, 1903. No. 38603 A.

Voiturette.

The 5-H.-P. Cottereau Voiturette. An illustrated detailed description. 1200 w. Auto Jour—Oct. 3, 1903. Serial. 1st part. No. 58275 A.

HYDRAULICS.

Hoist.

Hydraulic Coal Hoist at Glasgow Harbor. Illustration of the hoist and its approaches with information as to its construction. 1000 w. Engr, Lond—Oct. 16, 1903. No. 58486 A.

Hydraulic Machinery.

Diagrams for Estimating Hydraulic Machinery. Frank B. Kleinhaus. Gives diagrams with explanatory notes. 500 w. Eng. News—Oct. 22, 1903. No. 58635.

Pumps.

Riedler High-Speed Pumps (Riedler Expresspumpen.) H. Lehmann. Describing pumps recently installed at the Engelsburg mine near Bochum. The pumps run at 150 revolutions per minute and deliver 3.72 cubic metres per second against a head of 580 metres. 2000 w. Zeitsher d Ver Deutscher Ing—Sept. 19, 1903. No. 58515 D.

Safety Devices.

The Hydraulic Safety Devices of the Public Records Building at The Hague (De Hydraulische Veiligheidsinrichtingen van het Algemeen Rijks-Archiefgebouw te s'Gravenhage). W. Schlusen. Describing the complete system by which all doors, windows and other openings may be immediately closed by hydraulic power, providing protection against fire and burglary. 2500 w. De Ingenieur—Sept. 19, 1903. No. 58575 D.

Turbines.

A Comparison Between Axial Turbines and the Modern Radial Turbines (Vergleich zwischen Achsial turbinen und den Neueren Radialturbinen.) Prof. Pfarr. A discussion of the advantages of the Francis type of turbine over the older Jonval design, showing the reasons for the higher efficiency of the former. 2000 w. Zeitscher d Ver Deutscher Ing—Sept. 26, 1903. No. 58516 D.

Valves.

Stratton's Four-Way Hydraulic Valve. Illustrates and describes an ingenious device. 1200 w. Engng—Oct. 9, 1903. No. 58433 A.

Water-Powers.

Water Powers in the South. An illustrated article on the recent development, with especial reference to those of northern Georgia in the neighborhood of Gainesville and Dahlonega. 2500 w. Mines & Min—Oct. 1903. No. 58149 C.

See also Mechanical Engineering, Measurement.

MACHINE WORKS AND FOUNDRIES.

Apprentices.

See Industrial Economy.

Boring Machines.

Horizontal Boring Machines. Thomas R. Shaw. Gives a classification of these machines and begins an illustrated description of types of each class. 2000 w. Mech Engr—Oct. 3, 1903. Serial. 1st part. No. 58277 A.

Bridge Plant.

The Pennsylvania Steel Company's Model Bridge Plant. Part first gives an illustrated description of the general arrangement and principal features of the plant near Harrisburg, Pa. 5700 w. Eng Rec—Sept. 26, 1903. Serial. 1st part. No. 58136.

Castings.

Composition and Resistance of Steam Cylinder Castings (Zusammensetzung und Festigkeitseigenschaften des Dampfzylindergusses). F. Wüst & P. Goerens. With curves showing the strength and deflection of cast iron of various compositions. 2500 w. 1 plate. Stahl u Eisen—Oct. 1, 1903. No. 58539 D.

Steel Castings. Arthur Simonson. Considers the importance of design, and the construction of the pattern; and also more than all else, the quality of the steel. 1600 w. Foundry—Oct., 1903. No. 58231.

Chilled Iron.

Chilled Machine Tool Ways. Henry Hess. An illustrated article describing improvements due to the introduction of partially chilled guide surfaces and other applications. 1000 w. Am Mach—Oct. 8, 1903. No. 58327.

Cores.

A Responsible Job for the Coremaker. R. H. Palmer. Illustrates and describes the making of a difficult core. 1000 w. Am Mach—Oct. 15, 1903. No. 58393.

Crane Brakes.

Mechanical Crane Brakes. G. F. Dodge. Illustrations with description of a modified Western brake, in which the shell remains stationary. 1000 w. Am Mach—Oct. 29, 1903. No. 58672.

Crane Hook.

150-ton Crane Hook With Conical Roller Bearing. Ulrich Peters. Brief illustrated description. 200 w. Am Mach—Oct. 29, 1903. No. 58670.

Cranes.

See Electrical Engineering, Power Applications.

See Civil Engineering, Harbors.

Cutting Machines.

Machine for Cutting Circumferential Grooves in Steel Rolls—A Simple Chain Riveter. Brief illustrated descriptions of these machines. 800 w. Am Mach—Oct. 8, 1903. No. 58329.

Defects.

Machinery Defects and Their Causes. A review of the report of Mr. Michael Longridge, on engine, boiler, and motor breakdowns for the previous twelve months. 1800 w. Engng—Oct. 9, 1903. No. 58435 A.

Dies.

A Cutting, Bending and Forming Die. R. Lewis. Illustrated description of the die and its operation. 800 w. Am Mach—Oct. 15, 1903. No. 58394.

Automatic Slide Die for Piercing, Blanking and Drawing in One Operation. Joseph V. Woodworth. Illustrates and describes tools of improved design. 800 w. Am Mach—Oct. 22, 1903. No. 58616.

Compound Dies for Parts of Telephone Transmitter Cases. Joseph V. Woodworth. Illustrates and describes dies used in producing these parts. 2000 w. Ir Trd Rev—Oct. 1, 1903. No. 58224.

Electric Power.

See Electrical Engineering, Power Applications.

Eye-Bars.

The Making of 18-inch Steel Eye-bars. William R. Webster. A brief review of recent advances made in the annealing of eye-bars. 1000 w. Eng. News—Oct. 8, 1903. No. 58355.

The Method of Manufacturing the Large Eye-bars for the Thebes Bridge. P. S. Hildreth. Describes the making of the largest eye-bars used in bridge construction to date. 1200 w. Eng News—Oct. 8, 1903. No. 58356.

Filing.

A Foot-Power Filing Machine. Warren E. Willis. Illustrated description of a machine designed for use in die-making. 800 w. Am Mach—Oct. 29, 1903. No. 58668.

Foundry.

The Equipment of the Foundry. Joseph Horner. An illustrated article discussing especially the general shop, with departments for special work. 5500 w. Cassier's Mag.—Oct., 1903. No. 58690 B.

The Sturtevant Foundry. Illustrated description of the new foundry and pattern shop at Hyde Park, Mass. 2800 w. Ir Age—Oct. 29, 1903. No. 58667.

German Works.

Borsig's Works. Historical review and illustrated detailed description of these extensive works for the manufacture of boilers, locomotives, stationary engines operated by steam and gas, pumps, hydraulic presses, refrigerating appliances, &c. 4800 w. Engng—Oct. 9, 1903. Serial. 1st part. No. 58431 A.

Grinding.

Modern Cylindrical Grinding. C. H. Norton. Read before the Cincinnati Metal Trds. Assn. Reviews the development of grinding, the conditions of modern ground work, preparation, &c. 4000 w. Ir Trd Rev—Oct. 15, 1903. No. 58389

Heat Gauge.

The Heat Gauge in Twist Drill Work. Illustrated description of the device patented by Everett F. Morse, with information relating to the class of work to which it has been successfully applied. 1800 w. Ir Trd Rev—Oct. 1, 1903. No. 58225.

Hoisting.

Recent Hoisting Devices for Workshops (Neuere Ausführungen von Hebezeugen für Hüttenwerke). Illustrating and describing electric cranes, conveyors, charging machines, etc. Serial. Part I. 2500 w. Stahl u Eisen—Oct. 1, 1903. No. 58538 D.

Iron Works.

The La Belle Iron Works. An illustrated description of the improved works at Steubenville, Ohio. 3500 w. Ir Age—Oct. 8, 1903. No. 58264.

Jigs.

A Set of Jigs for Milling and Drilling. Joseph V. Woodworth. Illustrates and describes these tools. 1000 w. Am Mach—Oct. 8, 1903. No. 58330.

Machine Construction.

Recent Progress in Machine Construction (Neuere Fortschritte im Maschinenbau.) Hugo Seidler. A rapid review of the latest improvements in prime movers, including steam engines, hydraulic motors, and gas engines. Two articles. 6000 w. Zeitschr f Elektrotechnik—Sept. 20, 27, 1903. No. 58569 each D.

Metal Working.

The Modern Craft of Metal Working. Day Allen Willey. Brief illustrated description of methods of fashioning bronze, iron and other metals into ornamental work. 1000 w. Sci Am Sup—Oct. 3, 1903. No. 58177.

Milling Machine.

Constant Belt Speed Milling Machine. Illustrates and describes modifications in design to overcome the defects of the cone pulley as a means of driving the spindle, and of a variable spindle speed as a source from which to take the feed motion. 1500 w. Am Mach—Oct. 22, 1903. No. 58614.

Molding.

Floor Molding Without Patterns. Henry Hess. An illustrated description of improvements introduced in a foundry in Berlin, Germany. 1800 w. Foundry—Oct., 1903. No. 58230.

Instruction in Molding and Cupola Work. Thomas D. West. Part first is introductory, considering the branches of iron founding. 1000 w. Jour Am Found Assn—Oct., 1903. Serial. 1st part. No. 58689 H.

Lifting Pockets with Cores Instead of Grids or Bars. R. H. Palmer. Illustrates and describes methods used in molding. 1400 w. Am Mach—Oct. 29, 1903. No. 58673.

Molding a Thin Building Column. R. H. Palmer. Illustrated article describing the work. 1200 w. Am Mach—Oct. 1, 1903. No. 58160.

Piece Work.

The Fixing of Piece Work Rates. Hugo Diemer. Details of experience in the accurate fixing of piece work rates and the determination of speed records. 3000 w. Engineering Magazine—Nov., 1903. No 58582 B.

Punching.

The Hundhausen Ratchet System (Encliquetage Hundhausen). O. Arendt. Describing a combination of cams and ratchets applied to the feeding of dynamo discs under the punching press. Two articles. 4000 w. L'Electricien—Sept. 19, 26, 1903. No. 58576 each B.

Shaping Machine.

The Bauer Propeller-Blade Shaping Machine. An illustrated description of an important improvement for cutting or shaping the blades of ships' propellers. 1800 w. Engng—Oct. 9, 1903. No. 58434 A.

Speed Changing.

Automatic Lathe Speed Changing.

Howard A. Coombs. Illustrates and describes various arrangements of speed-changing devices, with remarks on their use. 1600 w. Am Mach—Oct. 15, 1903. No. 58392.

Speeds.

Speeds and Feeds. Frederick Holz. Read at meeting of the Cincinnati Metal Trds. Assn. An account of experimental work, and report of work accomplished. Ill. 2200 w. Ir Trd Rev—Oct. 8, 1903. No. 58323.

Steel Mills.

New Steel Plant and Merchant Bar Mills of the International Harvester Co., at South Chicago, Ill. Illustrated detailed description. 4400 w. Ir Trd Rev—Oct. 15, 1903. No. 58388.

Tools.

A New Drill and a Cam Miller. Illustrations, with brief descriptions. 4000 w. Engr, Lond—Sept. 25, 1903. No. 58215 A.

A Tool Room System. Describes a system in operation in one of the large works in the United States. 1800 w. Am Mach —Oct. 15, 1903. No. 58391.

Tests on Finishing and Annealing Heats F. C. Lau. From *Sparks from the Anvil.* Illustrated account of experiments conducted along the regular line of shop practice, with deductions. 1000 w. Metallographist—Oct., 1903. No. 58688 F.

Tube Works.

Universal Tube Works. Illustrates and describes these works situated at Chesterfield, Eng. 1200 w. Engng—Oct. 9, 1903. No. 58432 A.

Workbenches.

Westinghouse Workbenches. John Randol. Illustrations, with brief description. 1100 w. Am. Mach—Oct. 1, 1903. No 58159.

Works Management.

See Industrial Economy.

MATERIALS OF CONSTRUCTION.

Carborundum.

Manufacture and Uses of Carborundum. A. J. Fitz Gerald. Read before the Phila. Found. Assn. Deals with the origin of carborundum, present methods of manufacture, uses, characteristics, etc. 4000 w. Ir Age—Oct. 15, 1903. No. 58357.

Cast-Iron.

A Suggestion for a Test of the Effect of Silicon in Neutralizing Sulphur in Cast Iron. J. E. Johnson, Jr. Suggests a cheap and simple method to be carried out at the foundry. 800 w. Am Mach—Oct. 29, 1903. No. 58671.

The Chemistry and Physics of Cast Iron in the Light of Recent Knowledge. J. E. Johnson, Jr. A review of the advance made during the last three years, mentioning some important articles dealing with this subject which have appeared. 2200 w. Am Mach—Oct. 8, 1903. Serial. 1st part. No. 58328.

Manganese Steel.

The Properties and Constitution of Manganese Steel (Sur les Proprietés et la Constitution des Aciers au Manganese). Léon Guillet. A communication to the French Academy, giving the results of micrographic and mechanical investigations. 1000 w. Comptes Rendus—Sept. 21, 1903. No. 58521 D.

Microstructure.

Notes on the Microstructure of Steel. James E. Howard. Reviews the history of microscopic investigations and points emphasized by different investigators, concluding that the microscope may not yet be relied upon for the accurate determination of physical properties. 2800 w. Ir Age—Oct. 29, 1903. No. 58666.

Nickel Steel.

The Metallography of Nickel Steel. Léon Guillet. Translated from the *Bulletin de la Société d'Encouragement.* A study of the microstructure of various steels containing nickel from zero to 30 per cent. Ill. 6000 w. Metallographist —Oct., 1903. No. 58687 F.

Wire Rope.

High Grade Wire Rope. L. C. Moore. Considers the properties of standard cast steel, extra strong, and plow steel rope. 1800 w. Engrs' Soc of W Penn—Sept. 1903. No. 58446 D.

MEASUREMENT.

Depthometer.

Depthometer. Describes a recently patented instrument designed to show the depth of liquids either in open or closed vessels under any degree of pressure. 800 w. U S Cons Repts, No. 1772—Oct. 12, 1903. No. 58293 D.

Elastic Limit.

The Measurement of the Elastic Limit of Metals (Mesure de la Limite Elastique des Metaux). Ch. Frémont. Discussing the microscopic method of determining the true elastic limit at which the molecular structure of the material is changed under stress. 7000 w. Bull Soc d'Encour —Sept., 1903. No. 58526 G.

Gauges.

Micrometer Gages. A. L. Monrad. Illustrates and describes convenient tools. 1000 w. Am Mach—Oct. 29, 1903. No. 58674.

Shop Methods of Measurement and the Manufacture of Interchangeable Parts (Das Messen in der Werkstatt und die Herstellung Austauschbarer Teile). G.

Schlesinger. A discussion of the use of limit gauges in connection with automatic machine tools for the production of interchangeable machine parts. Two articles. 5000 w. Zeitschr d Ver Deutscher Ing—Sept. 19, Oct. 3, 1903. No. 58513 each D.

Metric System.

The Adoption of the Metric System in the United States (Adoption du Système Métrique aux Etats-Unis). Responses by the Society of Civil Engineers of France to a series of questions concerning the metric system put by the American Chamber of Commerce in Paris. 7500 w. Mem Soc Ing Civ de France—Aug., 1903. No. 58571 G.

The Metric System. The objections answered by the French Society of Civil Engineers. Extracts from this discussion. 2000 w. Ir Age—Oct. 8, 1903. No. 58265.

Section Moments.

A Study of Section Moments (Studie über Querschnitts Momente). Dr. Ludwig Hess. Developing equations for the determination of centrifugal moments and moments of inertia for structural shapes of various cross sections. 2000 w. Zeitschr d Oesterr Ing u Arch Ver—Oct. 2, 1903. No. 58534 D.

Temperature.

The Morse Thermo Gauge. Illustrated description of an apparatus for gauging the temperature to which steel is heated in the process of hardening or annealing. 500 w. Am Mach—Oct. 29, 1903. No. 58669.

Underflow.

Measurements of the Underflow at the Narrows of the Rio Hondo and San Gabriel River, California. Charles S. Slichter. Describes measurements made by the electrical method of the writer. 1800 w. Eng Rec—Oct. 17, 1903. No. 58467.

POWER AND TRANSMISSION

Compressed Air.

Compressed Air Equipment at Bradford Corporation Tramways, Car Shed and Workshops. An illustrated detailed description of the uses to which compressed air is put. 1700 w. Tram & Ry Wld—Oct. 8, 1903. No. 58426 B.

The Development of the Straight Line Air Compressor. R. S. Carter. Three illustrations, with descriptions, of types showing the periods of development, and the history of the machines. 900 w. Compressed Air—Oct., 1903. No. 58249.

See Electrical Engineering, Power Applications.

Conveyors.

Automatic Coal Conveyors for Boiler-Houses. Illustrated detailed description of the conveyors of the Central Electric Supply Company, London. 1200 w. Engr, Lond—Oct. 9, 1903. No. 58444 A.

New Rock-Handling Machinery. Alexander Forsyth. Illustrates and describes the skips, cars, and conveyors forming a part of the present system which has proved a success for the Portland Gold Mining Co. 1800 w. Eng & Min Jour—Oct. 3, 1903. No. 58256.

Wrightson's Patent Coal Shipper. Illustrates and describes an apparatus that claims minimum breakage of the coal. 900 w. Col Guard—Oct. 16, 1903. No. 58481 A.

Lumber.

The Transportation of Lumber. Waldon Fawcett. Illustrates and describes some of the improved methods in use 1800 w. Sci Am—Oct. 17, 1903. No. 58408.

Power Distribution.

The Distribution of Power for the Operation of Harbor Cranes (Mode de Transport et de Distribution de Force pour la Commande des Grues de Port). B. Lambert. A comparative study of the relative merits of hydraulic and electric power for harbor cranes. 8000 w. Revue de Mécanique—Sept., 1903. No. 58528 E + F.

Power Measurement.

See Electrical Engineering, Measurement.

Sheaves.

Design of Sheaves and Drums for Wire Rope. Samuel Diescher. Discusses some points affecting the strength and life of the rope. 3000 w. Engrs' Soc of W Penn—Sept., 1903. No. 58445 D.

SPECIAL MOTORS.

Alcohol Engines.

Use of Alcohol Engines in Europe. George E. Walsh. Remarks on the interest shown in these engines, and on some of the recent types. 1500 w. Ir Age—Oct. 22, 1903. No. 58468.

Carbon Disulphide.

Graphics of Carbon Disulphide, with Formulas and Vapor Table. Thomas M. Gardner. Shows the properties of this vapor, and its value as a working fluid for heat engines. 2000 w. Jour Fr Inst—Oct., 1903. No. 58290 D.

Carburetter.

A Paraffine Carburetter. Hugh Dolnar. An illustrated article explaining how paraffin is burned in the "Secor" engines. 1800 w. Autocar—Oct. 17, 1903. No. 58602 A.

The Improved Longuemore Carburetter. Illustrated description. 1500 w. Sci Am Sup—Oct. 10, 1903. No. 58374.

Combustion.

Phenomena of Alcohol Combustion. C. C. Longridge. Describes a series of experiments which gave facts of interest bearing upon the chemical theory—that the descomposition of the fuel improved the combustion and efficiency. 1700 w. Engr, Lond—Oct. 2, 1903. No. 58302 A.

Gas Engine.

A New Two-Cycle Gas Engine (Un Nouveau Moteur à Deux Temps). H. André. A description of the Doué motor with single oscillating cylinder, the compression being effected on the front side of the piston. 1200 w. Revue Technique—Sept. 25, 1903. No. 58510 D.

Gas Power.

See Electrical Engineering, Generating Stations.

Internal Combustion.

The Present Status of the Heat Engine (Der Heutige Stand der Wärmekraftmaschinen). Rudolf Diesel. A discussion of the availability of liquid fuel in internal-combustion engines, with especial reference to the Diesel Motor. 4000 w. Zeitschr d Ver Deutscher Ing—Sept. 19, 1903. No. 58511 D.

Oil Engines.

The Diesel Motor (Diesel Motoren). O. Kritzler. A comparison of the economical performance of the Diesel motor with other internal-combustion engines, showing its high efficiency. 2500 w. De Ingenieur—Sept. 19, 1903. No. 58574 D.

Trial of a Diesel Oil Engine and Riedler Pump. Report of a trial made to ascertain whether the guarantees given by the makers had been fulfilled. 2300 w. Prac Engr—Sept. 25, 1903. No. 58195 A.

Petroleum Spirit.

Properties of Petroleum Spirit or Hexane. J. S. Fowler and B. T. McCormick. Reports an investigation made of the action of petroleum in a heat engine. 1200 w. Sib Jour of Engng—Oct., 1903. No. 58683 C.

Petrol Motor.

Detachable Petrol Motor for Boat Propulsion. Brief illustrated description of a type of motor used in France. 500 w. Engng—Oct. 16, 1903. No. 58477 A.

See also Mechanical Engineering, Automobiles.

STEAM ENGINEERING.

Boilers.

A Locomotive Boiler with Water-Tube Firebox. An illustrated detailed description of the invention of J. Brotan, an Austrian engineer. Abstracted from an article in the *Zeitschrift des Oesterr. Ing. u. Arch. Vereins.* 2500 w. Eng News—Oct 1, 1903. No. 58182.

The Schutte Boiler and its Application to River Boats (Des Schütte-Kessel und seine Verwendung auf Flussschiffe). H. Hildebrandt. Illustrating a combined fire-tube and water-tube boiler, suitable for small boats. 2000 w. Zeitsch d Ver Deutscher Ing—Oct. 10, 1903. No. 58519 D.

Boiler Testing.

Diagrammatic Boiler Testing. W. H. Booth. Showing the advantage of a graphic record and the manner of preparing the diagram. 2000 w. Power—Oct., 1903. No. 58157 C.

Break Downs.

Engine Breakdowns. Michael Longridge. Particulars of steam, gas, and oil engine breakdowns, with the lessons they teach, taken from the annual report of the chief engineer of the Engine, Boiler & Employers' Liability Ins. Co. 5800 w. Mech Engr—Sept. 26, 1903. No. 58196 A.

Cylinder Clearance.

Effect of Cylinder Clearance upon the Quantity of Steam Consumed in Doing Specific Work, with Special Reference to Locomotive Practice. Ira C. Hubbell. A study of this subject, followed by discussion. 13500 w. N Y R R Club—Sept. 18, 1903. No. 58686.

Engine Bearings.

The Bearings of Naval Engines. Suggestions, based on experience, on the lubrication, adjustment, etc. 1800 w. Engr, Lond—Oct. 16, 1903. No. 58483 A.

Engine Friction.

The Distribution of Friction in an Engine and Shafting. Thomas L. Wilkinson. A discussion of friction loss, lubrication, and general practice. 3000 w. Min Rept—Sept. 24, 1903. No. 58164.

Engines.

The Newcomen Engine. Henry Davey. Facts of interest in regard to the invention and construction of the first steam-engine—the Atmospheric Engine of Newcomen. Illustrations, with ten appendices 13000 w. Inst of Mech Engrs—Oct. 16, 1903. No. 58607 D.

Engine Test.

Test of a Compound Engine. E. F. Williams. Gives briefly the results of preliminary economy tests of a vertical compound engine at the New York Navy Yard. 900 w. Power—Oct., 1903. No. 58158 C.

Exhaust Steam.

The Utilization of Exhaust Steam (Die Ausnutzung des Auspuffdampfes). Julius Divis. Discussing especially the Rateau steam accumulator and the use of exhaust steam in low-pressure steam turbines. Two articles. 4000 w. Oesterr Zeitschr f Berg u Hüttenwesen—Sept. 19, 26, 1903. No. 58551 each D.

Feed Water

Feed-Water Purification. Walter W. Edwards. Part first considers the mechanical methods employed. 2200 w. Engr, U. S. A.—Oct. 15, 1903. Serial. 1st part. No. 58395 C.

Some Sources of Error in Water Treatment. H. Spencer Flynt. A review of accepted methods of purification of waters for boiler feed, showing the necessity for intelligent supervision and care to avoid either under or over treatment. 2000 w. Engng Mag—Nov., 1903. No. 58585 B.

Water-Softening Plants, Pennsylvania Co. Describes the plant at Middlepoint, Ohio, where a machine capable of softening 10,000 gallons of water an hour is in use. 700 w. R R Gaz—Oct. 2, 1903. No. 58267.

Water Treatment in Railroad Operation. G. R. Henderson. A brief paper on what has been accomplished and the results of treating water before it is taken on the tender. Followed by lengthy general discussion. 7500 w. W Ry Club—Sept. 22, 1903. No. 58367 C.

Flow.

Flow of Steam or Gases Through a Nozzle. Sanford A. Moss. An explanation of the expansion of Gases, the effect of the shape of nozzles, etc. 1800 w. Engr, U. S. A.—Oct. 15, 1903. No. 58396 C.

Governor.

The Racing Check: A New Marine Engine Governor. Illustrated description. 1000 w. Prac Engr—Oct. 16, 1903. No. 58496 A.

Mechanical Draft.

On the Design and Testing of Centrifugal Fans for Induced Draught and Other Purposes. W. Gilbert. Read before the Civil & Mech. Engrs.' Soc. Somewhat supplementary to a previous paper read in 1895. Describes installations of fans of the larger sizes, and gives particulars of some tests. 4000 w. Engng—Oct. 9, 1903. No. 58438 A.

Safety Valves.

Notes on Safety Valve Practice. R. S. Hale. Discusses the size of valves to be used and ways of improving safety valve practice. 1600 w. Engr, U. S. A.—Oct. 1, 1903. No. 58243 C.

Steam Production.

Steam Production in Locomotives. R. Gordon Sharp. Discusses firing and the causes of poor combustion, suggesting means of remedying. 2000 w. Engr, Lond—Oct. 16, 1903. No. 58484 A.

Steam Turbines.

Advantages of Steam Turbines for Textil Mills. Austin R. Dodge. Condensed from paper read before the New England Cotton Mfrs.' Assn. Describes various types of turbines in use and considers their adaptability to the requirements of textile mills. 2000 w. Ill. Eng News—Oct. 22, 1903. No. 58634.

Elementary Theory of the Steam Turbine (Théorie Elémentaire des Turbines à Vapeur). A. Rateau. Deriving the fundamental equations governing the action of fluid jets upon rotating wheels, with applications to impact and reaction steam turbines. 5000 w. Revue de Mécanique—Sept., 1903. No. 58527 E + F.

Stokers.

Mechanical Stokers. Thomas L. Wilkinson. The present article reviews the causes that have stimulated the invention of mechanical stokers. 1200 w. Min Rept—Oct. 15, 1903. Serial. 1st part. No. 58451.

Stoking-Indicators.

Kilroy's Stoking-Indicators. An illustrated description of an apparatus devised with the object of facilitating the uniform firing of boiler furnaces, thus securing a maximum coal efficiency and a minimum of smoke production. 1500 w. Engng—Oct. 2, 1903. No. 58294 A.

Superheating.

Test of a Superheated Steam Plant at Niechcice, Russia (Abnahmeversuche an einer Heissdampfanlage in Niechcice). M. Westphal. Data and results of test of a compound engine of 240 horse power, with steam superheated 350 degrees C. 2000 w. Zeitschr d Ver Deutscher Ing—Sept. 19, 1903. No. 58514 D.

Valve Gears.

The Valve Gears of Modern Mill Engines. Charles Hurst. An illustrated description of recent types. 3300 w. Feilden's Mag—Oct., 1903. No. 58471 B.

MISCELLANY.

Aeronautics.

A Balloon Trip Over the Alps. An account of the recent trip made by Capt. Spelterini, accompanied by a party of aeronauts and scientists. 1000 w. Sci Am Sup—Oct. 24, 1903. No. 58652.

The Failure of Langley's Aerodrome. A brief illustrated account of the last experiment with this machine, and its disaster, with explanations. 800 w. Sci Am—Oct. 17, 1903. No. 58405.

The Flight of Birds Mechanically Studied. Emile Guarini. An illustrated study. 1200 w. Sci Am—Oct. 10, 1903. No. 58368.

The Lebaudy Airship. A short illustrated description with account of preliminary experiments. 1700 w. Sci Am Sup—Oct. 10, 1903. No. 58373.

Automatic Counting.

Automatic Apparatus for Counting and Registering Casks. Illustrates and describes an invention of Thomas Forsyth designed for the accurate counting, measuring and registering of casks or barrels and recording the result. 800 w. Engng—Oct. 16, 1903. No. 58478 A.

Band-Saw.

Horizontal Log Band-Saw. An illustrated description with statement of advantages claimed. 1800 w. Engng—Oct 16, 1903. No. 58479 A.

Blowpipe.

The Oxygen-Acetylene Blowpipe (Le Chalumeau Oxy-Acétylénique). E. Fouché. A description of the conditions under which acetylene and oxygen may be successfully used in the blowpipe to produce very high temperatures, with sectional drawing of blowpipe. 3000 w. Génie Civil—Sept. 26, 1903. No. 58502 D.

Glass Working.

The Mechanical Manufacture of Bottles (Fabrication Mécanique des Bouteilles). L. Appert. A review of the various mechanical processes which have been proposed for making glass bottles, concluding with the Boucher machine, now in most successful operation. 6000 w. Bull Soc d'Encour—Sept., 1903. No. 58-525 G.

The Sievert Process of Mechanical Glass Blowing. An illustrated article describing practical applications of this process. 800 w. Sci Am—Oct. 3, 1903. No. 58171.

Heating.

Heating Experiments with Oils and Manufactured Gas. B. T. Galloway. Notes from the *Florists' Exchange,* respecting experiments with some new devices for heating water for use in radiators, with gas and oil as fuels. Ill. 2200 w. Am Gas Lgt Jour—Oct. 26, 1903. No. 58663.

Refrigeration.

A Comparison of Old and Recent Tests of Ammonia Compression Refrigerating Machines (Vergleich Aelterer und Neuerer Versuchsergebnisse von Ammoniak-Kompressions-Kältemaschinen). G. Döderlein. Giving tabulated results of tests, and deducing formulas for use in computation. 3000 w. Zeitschr d Ver Deutscher Ing—Oct. 10, 1903. No. 58518 D.

The Miller System of Mechanical Refrigeration. Illustrated description of an ice-making machine operated from the car axle. 2500 w. R R Gaz—Oct. 23, 1903. No. 58644.

Residence Heating.

Heating and Ventilating in the Carnegie Residence, New York. An illustrated description of an example of fine workmanship. The heating plant is mainly an indirect one, but is supplemented by exhaust fans. 4500 w. Eng Rec—Oct. 3, 1903. No. 58263.

MINING AND METALLURGY

COAL AND COKE.

Borings.

Coal Borings in the Pas-de-Calais Coal-Field. Condensed report of recent mining explorations made in this vicinity. 1000 w. Col Guard—Oct. 16, 1903. No. 58-482 A.

Cannel Coal.

Kerosene Shale, or Cannel Coal Seams at Preolenna, Tasmania. Interesting details from the report of W. H. Twelvetrees. Map. 900 w. Ir & Coal Trds Rev—Oct. 2, 1903. No. 58306 A.

Coal Fields.

Barela Mesa Coal Field. J. E. McLaughlin. Information concerning deposits near Trinidad, Colorado. 700 w. Mines & Min—Oct., 1903. No. 58156 C.

Coal Storage.

The Storage of Steam Coal Under Water. Two letters written by Mr. John Macaulay to the London *Times,* on experiments carried out to find the best method of storing large quantities of coal. 2700 w. Prac Engr—Oct. 2, 1903. No. 58276 A.

Coal Syndicate.

See Industrial Economy.

Glapwell Colliery.

Notes on Glapwell Colliery. Maurice Deacon. Describes the surface plant, ventilation and underground arrangements. General discussion. 4500 w. Col Guard—Oct. 9, 1903. No. 58428 A.

Gob-Fires.

Gob-Fires, Their Theory and Practice. George Farmer. Read before the Yorkshire Branch of the Nat. Assn. of Col. Mgrs. Deals with spontaneous combustion, and the problem of gob-fires, their causes, prevention, and means of extinction. 5800 w. Ir & Coal Trds Rev—Sept. 25, 1903. No. 58219 A.

Indian Territory.

Coal Mining in the Indian Territory—

The Southwestern Field. W. R. Crane. Map and illustrated description of this field, the methods of mining, cost, products, etc. 4200 w. Eng & Min Jour—Oct. 17, 1903. No. 58461.

Japan.

The Takaśima Coal Mines of Nagasaki, Japan. E. W. Hardin. A finely illustrated article describing mines having unusual features. 1700 w. Page's Mag—Oct., 1903. No. 58469 B.

New Zealand.

The State Coal Mines. Reports of the Point Elizabeth coal mine, and the Seddonville coal mine. 2500 w. N Z Mines Rec—Sept. 16, 1903. No. 58489 B.

Sinking.

Sherwood Colliery Sinking. J. W. Fryar. Describes the sinking to a depth of 1,302 ft., the diameter of the shaft being 20 ft. The time occupied was 54 weeks. Discussion. 5000 w. Col Guard —Oct. 2, 1903. No. 58291 A.

COPPER.

Arizona.

Copper Deposits of Bisbee, Arizona. Condensed from Ransome's contribution to U. S. Geol. Survey. Describes the geology of the district and occurrence of ores. 1500 w. Min Rept—Oct. 1, 1903. No. 58222.

British Columbia.

Ore Quarrying in the Boundary District, British Columbia. E. Jacobs. A well illustrated description of the open copper mines of the district, showing the great field for new methods and machinery. 4000 w. Engineering Magazine—Nov., 1903. No. 58586 B.

Concentration.

Method of Concentrating at La Cananea. Martin Schwerin. Describes the concentrating plant of the Greene Consolidated Copper Co. in Mexico, designed for a capacity of 600 tons per day. 1500 w. Eng & Min Jour—Sept. 26, 1903. No. 58132.

Cyandide Assay.

Improvements in the Cyanide Assay for Copper. Thorn Smith. Describes the methods now used by the writer, which he considers "the best by far of the volumetric methods." 1200 w. Eng & Min Jour—Oct. 17, 1903. No. 58462.

GOLD AND SILVER.

Africa.

Gold in the Dioritic Rock from Mashonaland. J. E. Spurr. A microscopic study of a specimen of auriferous dioritic rock. Ill. 1100 w. Eng & Min Jour—Oct. 3, 1903. No. 58255.

Amalgamation.

Raw Copper Plates. On the selection and care of these plates when used for amalgamation of gold ores; the preparation and treatment necessary to secure good results. 2500 w. Min & Sci Pr—Sept. 19, 1903. No. 58119.

The Practice of Amalgamation. W. H. Kritzer. Notes on the manipulation of mercury and care of plates. 2200 w. Pacific C Min—Oct. 10, 1903. No. 58382.

British Columbia.

Through the Lardeau. Notes of a trip through this country where unusually rich gold-bearing ore has recently been found. General information with map. 5400 w. B C Min Rec—Oct., 1903. No. 58319 B.

California.

The Dorleska Gold Mine. H. Z. Osborne. An account of the rapid development of this mine in Trinity Co., California, with illustrations. 2000 w. Min & Sci Pr—Oct. 17, 1903. No. 58611.

Costs.

Mining Costs on the Rand and in New Zealand. From the annual report on portions of the West Coast Gold Fields for 1902. A comparison of expenses of working. 2000 w. N Z Mines Rec—Sept. 16, 1903. No. 58488 B.

Cyaniding.

Consumption of Zinc on Cyanide Plants. Walter H. Virgoe. Considers the loss due to mechanical and to chemical causes, and the excessive losses, discussing questions bearing upon this subject and defending the use of zincic potassic-cyanide. 9000 w. Jour Chem & Met Soc of S Africa—Aug., 1903. No. 58193 E.

Gold Fields.

Gold Fields of the Atlantic Slope. C. L. Dignowity. Condensed from Trans. Am. Min. Cong., Deadwood, S. D. A brief account of the deposits in N. Carolina, Virginia and the Southern field, the conditions, methods, etc. 1800 w. Min & Sci Pr—Sept. 19, 1903. No. 58120.

Hydraulic Mining.

Hydraulic Mining in Southern Oregon. Dennis H. Stovall. An illustrated account of placer mining, and the extensive placer field of this region. 1300 w. Min & Sci Pr—Oct. 3, 1903. No. 58331.

Mexico.

The Mines of the Pinitos and Azul Mountains, Sonora, Mexico. Reginald W. Petre. Outlines the history of the region, explaining why the gold and silver mines remain undeveloped. 1600 w. Eng & Min Jour—Sept. 26, 1903. No. 58134.

Montana.

Big Indian Mine. Colin McIntosh. Illustrated description of a Montana gold mine and mill. The method of mining is by the open-cut and mill-hole system.

1800 w. Min & Sci Pr—Oct. 10, 1903. No. 58454.

Nicaragua.

Gold Fields of Eastern Nicaragua. Information concerning the mineral regions, labor, wages, water, wood, etc. 3000 w. U S Cons Repts, No. 1774—Oct. 14, 1903. No. 58365 D.

Ore Treatment.

The Greenawalt Electro-Chlorination Process. John E. Greenawalt. An illustrated detailed description. 1400 w. Min Rept—Oct. 8, 1903. No. 58317.

Quartz Milling.

Notes on the Common Practice of Quartz Milling on the Rand. Discussion of the paper by Fraser Alexander. 3000 w. Jour Chem & Met Soc of S Africa—Aug., 1903. No. 58192 E.

Queensland.

Gold Workings in the Perry Scrub, Burnett District. Lionel C. Ball. Gives the location, topography, geology, etc., describing the workings. Map. 5000 w. Queens Gov Min Jour—Aug. 15, 1903. No. 58189 B.

Silver Ores.

The Occurrence of Lead, Cobalt and Nickel Ores Containing Silver, near Pressnitz, Bohemia. (Die Vorkommen von Silberhältigem, Bleiglanz, Kobalt und Nickelerz bei Pressnitz im Böhmischen Erzegebirge). Josef Lowag. A general description of the geological conditions. 1500 w. Oesterr Zeitschr f Berg u Hüttenwesen—Sept. 26, 1903. No. 58552 D.

Slimes.

What Constitutes a Slime? W. J. Sharwood. Calls attention to some of the definitions suggested as applied to certain classes of tailings, or crushed ore, in connection with lixiviation and concentration processes. 1400 w. Eng & Min Jour—Oct. 10, 1903. No. 58347.

Supply.

The Supply of Gold. Address of Mr. George E. Roberts, Director of the United States Mint, at American Mining Congress. 2500 w. Min Rept—Oct. 8, 1903. No. 58318.

Thunder Mountain.

Thunder Mountain Region. Illustrated description of this gold region of Central Idaho, giving information in regard to the deposits, development, etc. 2000 w. Min Rept—Sept. 24, 1903. No. 58165.

Transvaal.

Developments in the Heidelberg District, Transvaal. T. Lane Carter. A report of recent investigations made in this gold mining district. Ill. 1200 w. Eng & Min Jour—Oct. 17, 1903. No. 58463.

IRON AND STEEL.

Alloys.

Alloys Used for Steel Making. Dr. J. Ohly. Considers the compositions and effects upon the properties of steel of some alloys now in use. 2200 w. Mines & Min—Oct., 1903. Serial. 1st part. No. 58150 C.

Bilbao.

The Bilbao Iron Mines. C. Mackay-Heriot. Outlines the history of these Spanish mines, describing the geological conditions, ore occurrence, methods of extraction, etc. Ill. 2800 w. Eng & Min Jour—Oct. 3, 1903. No. 58258.

Castings.

See Mechanical Engineering, Machine Works and Foundries.

Cast Iron.

See Mechanical Engineering Materials.

Iron Works.

See Mechanical Engineering, Machine Works and Foundries.

Manganese Steel.

See Mechanical Engineering, Materials.

Nickel Steel.

See Mechanical Engineering, Materials.

Open-Hearth.

Open-Hearth Steel Making and Blast Furnace Gas in Gas Engines. Peter Eyermann. From a paper read before the Civ. Engrs. Club of Cleveland. Illustrates types of gas engines suited for the use of blast-furnace gas, and discusses the economies to be effected in the consumption of coal, etc. 5000 w. Ir Trd Rev—Oct. 22, 1903. No. 58612.

Steel.

Testing Brittleness of Steel. E. G. Izod. Read before the British Assn. An illustrated description of a pendulum apparatus for testing steel as regards brittleness. 1500 w. Engng—Sept. 25, 1903. No. 58210 A.

Steel Mills.

See Mechanical Engineering, Machine Works and Foundries.

Steel Trade.

See Industrial Economy.

MINING.

Accidents.

Fatal Accidents in Coal Mines of North America. Frederick L. Hoffman. Some facts bearing upon the gradual increase in the fatality rate. 900 w. Eng & Min Jour—Sept. 26, 1903. No. 58133.

Accounting.

A Card System for Mine Supply Accounts. F. W. Denton. Read before the Lake Superior Min. Inst. Describes a method by which the amount and value of supplies on hand can always be known. 1800 w. Mines & Min—Oct., 1903. No. 58152 C.

Mine Accounting. Walter M. Jeffery. Read before the Lake Superior Min. Inst. Shows the importance of uniform systems for all mines under same ownership. 3400 w. Mines & Min—Oct., 1903. No. 58151 C.

Electric Transmission.

See Electrical Engng, Transmission.

Intake Tunnel.

Intake Tunnel for the Champion Mill, at Painesdale, Mich. F. W. O'Neil. Abstract of a paper for meeting of the Lake Superior Min. Inst. An illustrated description of the work, with reasons for the method adopted. 4500 w. Eng News—Oct. 1, 1903. No. 58181.

Mine Cars.

Car for Handling Rock at Mines. L. L. Logan. An illustrated description of an arrangement for handling and dumping mine cars loaded with rock. 1000 w. Mines & Min—Oct., 1903. No. 58154 C.

Mine Gases.

Some Mine Gases: Their Toxicology and Possible Connection with Miner's Phthisis. Discussion of paper by A. Heymann. 1200 w. Jour Chem & Met Soc of S Africa—Aug., 1903. No. 58191 E.

Mine Signalling.

Signalling Between Levels. F. B. Allen. Notes on a new system of signalling at Bayley's gold mines, Coolgardie. Ill. 900 w. N Z Mines Rec—Aug. 17, 1903. No. 58190 B.

Mine Watering.

A Portable Tank for Watering Roadways in Mines. W. Galloway. Read before the South Wales Inst. of Engrs. Briefly describes various appliances that have been used, especially an invention of the writer's, in which compressed air expels the water. Ill. 1600 w. Ir & Coal Trds Rev—Oct. 2, 1902. No. 58307 A.

The Spraying or Watering Problems of Dusty Mines. James Ashworth. Considers dangers connected with spraying, as shown by reports of various experiments and dust explosions. 4500 w. Mines & Min—Oct., 1903. No. 58147 C.

Preparation.

The Mechanical Preparation of Minerals (La Préparation Mécanique des Minerais). Paul Machavoine. A discussion of methods of separation and concentration of ores, based not only upon the physical properties, but also upon the local conditions of labor, transport, etc. 4000 w. Mem Soc Ing Civ de France—Aug., 1903. No. 58572 G.

Roads.

Good Roads for Mines. James W. Abbott. Read at the Am. Min. Cong. The importance of highway improvement, particularly in its effect upon the mining industry. 2000 w. Min Rept—Sept. 24, 1903. No. 58166.

Rock-Salt.

Mining and Manufacture of Rock Salt. F. E. Englehardt. An illustrated description of methods used in the mines of New York State. 2500 w. Sci Am Sup—Oct. 3, 1903. Serial. 1st part. No. 58176.

Safety Catches.

Safety Catches for Mine Haulage Apparatus (Sicherheitsvorrichtungen au Bremsbergen). Gustav Ryba. Describing a number of forms of safety brakes and catches for checking the fall of cars and cages on mining inclines and hoists. Two articles. 1 plate. 4000 w. Osterr Zeitschr f Berg u Hüttenwesen—Oct. 3, 10, 1903. No. 58553 each D.

Safety Device.

The Karlik-Witte Safety Device for Mine Hoisting Machinery (Der Sicherheitsapparat für Fördermaschinen Patent Karlik-Witte). The apparatus includes indicators showing the position of the cages in the shaft and an automatic brake to prevent overwinding. 2500 w. Glückauf—Sept. 19, 1903. No. 58547 D.

Shaft Sinking.

Progress at the Dover Colliery: Shaft Sinking by the Kind-Chaudron System. An illustrated account of the progress made at No. 2 pit, where great quantities of water were encountered. 1200 w. Col Guard—Sept. 25, 1903. No. 58204 A.

Report upon the Methods of Transporting Material in the Mines of Upper Silesia (Bericht über das Schlammversatzverfahren auf den Oberschlesischen Bergwerken). K. Müller & H. Hussmann. A description of the methods employed for raising mud, sand and semi-fluid materials in sinking mine shafts. 6000 w. 1 plate. Glückauf—Sept. 26, 1903. No. 58548 D.

Sinking and Equipping No. 9 Shaft, at Ashland Mine, of the Cleveland-Cliffs Iron Company, at Ironwood, Michigan. H. F. Ellard. Read before the Lake Superior Min. Inst. An illustrated detailed description of the work. 3200 w. Mines & Min—Oct., 1903. No. 58153 C.

Timbering.

Drift Timbering. W. H. Storms. Sketches illustrating some of the principles of drift timbering under the conditions usually encountered. 1500 w. Min & Sci Pr—Oct. 10, 1903. Serial. 1st part. No. 58332.

Veins.

Identity and Continuity of Veins. Some

extracts from the work of C. H. Lindley on mines, discussing mining laws bearing upon veins, with comments. 2000 w. Min & Sci Pr—Oct. 10, 1903. Serial. 1st part. No. 58453.

MISCELLANY.

Antimony.

The Mineralogy, Metallurgy and Commercial Application of Antimony. Dr. J. Ohly. On the value and uses of antimony ore. 2000 w. Min Rept—Oct. 1, 1903. No. 58223.

Asbestos.

The Production of Asbestos in 1902. Joseph Hyde Pratt. Condensed from a Bul. of the U. S. Geol. Survey. Concerning the sources of supply and the production. 1200 w. Eng News—Oct. 15, 1903. No. 58404.

Asphaltum.

The California Asphaltum Industry. F. H. Minard. Outlines the occurrence and character of the deposits of crude oil in California, and the process of refining for asphaltum. Ill. 3500 w. Eng & Min Jour—Oct. 3, 1903. No. 58257.

Diamonds.

The Mechanical Equipment of the Kimberley Diamond Mines. Charles V. Allen. Mr. Allen's second article deals with the electric, pneumatic, steam and general machinery of advanced design in use at Kimberley. 4000 w. Engineering Magazine—Nov., 1903. No. 58583 B.

Lead.

The Metallurgy of Lead. H. O. Hofman. Reprinted from an article in the new volumes of the *Encyclopedia Brittanica.* Describes methods in use. 4000 w. Tech Qr—Sept., 1903. No. 58386 E.

Mineral Industry.

Notes on the History of the Mineral Industry in the Nineteenth Century. Willet G. Miller. An interesting review. 10000 w. Can Min Rev—Sept. 30, 1903. No. 58228 B.

Petroleum.

The Petroleum Districts and Mud Volcanoes of Java. A. Bosch. An illustrated article describing the oil deposits of Java. 1200 w. Sci Am—Oct. 10, 1903. No. 58369.

The Refining of California Petroleum. Dozier Finley. From the *California Jour. of Tech.* Considers the character of these oils, their applications, methods of refining, etc., comparing the products with the Eastern. 3800 w. Pacific C Min—Sept. 26, 1903. No. 58221.

Platinum.

Platinum. Remarks on the many uses of this metal, its production, the principal deposits known, etc. 1200 w. Aust Min Stand—Sept. 3, 1903. No. 58188 B.

Quicksilver.

Quicksilver Reduction at New Almaden, Cal. Walter W. Bradley. A short description of the operations at the reduction works, with illustration. 1000 w. Min & Sci Pr—Sept. 26, 1903. No. 58229.

The Quicksilver Deposits of Oregon. W. B. Dennis. Reviews the condition of quicksilver, the steady decline in production, and gives an account of the deposits discovered in Oregon. Ill. 3400 w. Eng & Min Jour—Oct. 10, 1903. No. 58346.

Thermite.

Goldschmidt Method of Metallurgy and High Temperature Production by Means of Thermite. B. Palmer Caldwell. An explanation of thermite and its action. 2000 w. Jour Assn of Engng Socs—Aug., 1903. No. 58168 C.

Uranium.

Uranium. Describes this metal and some of its oxides which have been found useful. 1700 w. Aust Min Stand—Aug. 27, 1003. No. 58187 B.

Vanadium.

The Applications of Vanadium in Metallurgy (Le Vanadium en Métallurgie). S. Marsollan. A study of the influence of vanadium upon iron and steel, showing the increase produced in resistance. Two articles. 4000 w. Revue Technique—Sept. 25, Oct. 10, 1900. No. 58508 each D.

Vanadium. Describes this rare metal, giving much information concerning it. 1800 w. Aust Min Stand—Aug. 20, 1903. No. 58186 B.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

Acceleration Tests.

Acceleration Tests on the Great Eastern of England. A detailed account of tests made with a new 10-coupled suburban tank engine. 900 w. R R Gaz—Sept. 25, 1903. No. 58139.

Fast Trains.

The Fastest Trains in the United States. W. A. Schulze, in *Zeitung des Vereins.* Three short articles on the speed of American trains, giving tables. 3800 w. Bul Int Ry Cong—Sept., 1903. No. 58274 E.

Grain.

Relations of Railroads to the Grain

Trade. F. A. Delano. Discusses points in facilitating the economical and rapid handling of grain, the improvements made and needed. 3700 w. Ry Age—Oct. 16, 1903. No. 58448.

Resistance.

Some Notes on Train Resistance. C. F. Dendy Marshall. Investigates details given by C. J. Bowen Cooke, of experiments carried out with the dynamometer van on the North-Western Railway, and the figures given by J. A. F. Aspinall in a paper read before the Inst. of Civ. Engrs. 2800 w. Engr, Lond—Oct. 2, 1903. No. 58300 B.

MOTIVE POWER AND EQUIPMENT.

Air Brakes.

Maintenance of Air Brakes Under Freight Cars. W. C. Hunter. Extracts from a paper read before the Canadian Ry. Club. Concerning the repairs and the methods of the Intercolonial Ry. 1200 w. R R Gaz—Oct. 16, 1903. No. 58397.

Axle Failures.

Axle Failures in Germany. Figures taken from an article by M. E. Biard in the *Revue Generale des Chemins de Fer*, which gives an analysis of failures for the years 1888 to 1900. 1200 w. R R Gaz—Oct. 9, 1903. No. 58348.

Brake Tests.

Some Competitive High-Speed Brake Tests. Gives tabulated results of tests made by the Central Railroad of New Jersey. 800 w. Loc Engng—Oct., 1903. No. 58285 C.

Cars.

Composite Gondola Cars, C. B. & Q. R. R. An illustrated description of 100,000 lbs. capacity cars. 1000 w. Ry & Engng Rev—Oct. 24, 1903. No. 58662.

Steel Frame Side Door Suburban Cars of the Illinois Central R. R. Full illustrated detailed description of this new type. 3200 w. Ry Mas Mech—Oct., 1903. No. 58605.

Counterbalancing.

Counterbalancing Locomotive Driving Wheels. Editorial reviewing early rules for the counterbalancing of driving wheels. 1300 w. Loc Engng—Oct., 1903. No. 58161 C.

Driving Wheels.

The Unresilient Driving Wheel. Editorial on the need of an invention to soften the blow of tires on the track and to reduce the noise. 900 w. Loc Engng—Oct., 1903. No. 58162 C.

Feed Water.

See Mechanical Engng., Steam Engineering.

Locomotive Boilers.

Special Features in the Design of Locomotive Boilers and Fireboxes. Charles S. Lake. Mr. Lake's second paper treats especially of recent examples of boiler design in British locomotives, including the use of water tubes, corrugated furnaces and superheaters. 3000 w. Engineering Magazine—Nov., 1903. No. 58584.

Locomotive Design.

Locomotive Proportion. F. K. Caswell. The second in a series of graphical charts relating to locomotive design, with notes. 1000 w. Ry & Engng Rev—Oct. 3, 1903. No. 58311.

Locomotive Frames.

A Rational Method of Design of Locomotive Frames. Abstract of a paper by G. S. Edmonds, presented at meeting of the Pacific Coast Ry. Club. Gives facts based on the examination of some 100 designs of representative product. 1500 w. R R Gaz—Oct. 9, 1903. No. 58350.

Locomotives.

A New Consolidation Locomotive for the Long Island Railroad. An illustrated description of Engines with Wooten type of boilers, having grates adapted for burning either lump or fine anthracite or bituminous coal, or a mixture. 300 w. Ry Age—Oct. 9, 1903. No. 58326.

Big Locomotives and the Compound. Editorial discussion of the big engines, their failures, and how to make them satisfactory. 900 w. Am Engr & R R Jour—Oct., 1903. No. 58239 C.

Class D2 Mogul (2-6-0) Locomotive for the "Soo Line." Illustration with general description. 500 w. R R Gaz—Oct. 23, 1903. No. 58645.

Continental Locomotive Types. Charles S. Lake. Begins a general survey of the principal modern types used on the continent. 1200 w. Prac Engr—Oct. 16, 1903 Serial. 1st part. No. 58495 A.

Experiments with a New Type of Compound Locomotive in Italy. The first of a series of articles describing the new type in use on the Adriatic railways, its development and working results. The boiler is reversed on the frames so that the firebox fits into the space above the bogie trucks. 3500 w. Engr, Lond—Oct. 2, 1903. No. 58299 A.

Heaviest Locomotive Ever Built. Illustration and chief characteristics of the 2-10-2 type, tandem compound, built for the A. T. & S. F. Ry. 200 w. Am Engr & R R Jour—Oct., 1903. No. 58240 C.

New Passenger Locomotives. Illustration, with description of the Pacific, or 4-6-2 type, passenger engine for the C., R. I. & P. Ry. 500 w. Am Engr & R R Jour—Oct., 1903. No. 58237 C.

New 2-8-0 Freight Locomotive, N. & W. Ry. Illustrated description of interesting features. 700 w. Ry & Engng Rev—Sept. 25, 1903. No. 58169.

Note on Modern Locomotives. P. F. Kupka. A sketch of the present condition of locomotive building, limited to the last five years, and to heavy locomotives. Ill. 2000 w. Bul Int Ry Cong—Sept., 1903. No. 58273 E.

Philadelphia & Reading Double-End Interurban Engine. Illustration, elevation, cross sections and brief description of an engine for suburban service. 400 w. Ry Age—Sept. 25, 1903. No. 58118.

Pittsburg & Lake Erie Atlantic Locomotive. Illustrated description of engine for hauling heavy passenger trains. 700 w. Ry Age—Oct. 16, 1903. No. 58449.

Some Notes on Recent Fast Passenger Locomotives. Notes the greatest development of passenger locomotives since 1900, giving illustrations of designs. 1100 w. Sib Jour of Engng—Oct., 1903. No. 58684 C.

Tandem Compound "Santa Fe" Type (2-10-2) Locomotive for the Santa Fe. Illustrated descriptions. 500 w. R R Gaz —Oct. 9, 1903. No. 58351.

Ten-Wheel Express Locomotive. Illustrated description of a large engine to be used in service between London and Glasgow. 600 w. Engng—Sept. 25, 1903. No. 58207 A.

The Proportions of Modern Locomotives. Lawford H. Fry. Investigations covering over 250 locomotives, showing the tendencies of American practice, and comparing the dimensions. Also discussion. 13,600 w. Pro N Y R R Club—Sept. 18, 1903. No. 58685.

Motor Coach.

Great Western Railway Steam Motor Carriage. Illustrated description of a coach recently put in service in England. 600 w. Engr, Lond—Oct. 16, 1903. No. 58485 A.

Steel Cars.

Steel Car Development. Historical review, with illustrated details of the more important designs, and discussion of the principles involved in their construction. 1800 w. Am Engr & R R Jour—Oct., 1903. Serial. 1st part. No. 58238 C.

Train Lighting.

Electric Train Lighting (Elektrische Zugsbeleuchtung). A description of the Vicarino system, as introduced on the Swiss Government railways. A dynamo driven from the car axle is used. 1500 w. Schweiz Bauzeitung—Sept. 19, 1903. No. 58554 B.

Two Systems of Using Acetylene Gas for Car Lighting. Abstract of a paper by E. G. Fisher read at meeting of the International Acetylene Assn. in Chicago; also a summary of the Elliott & Wilson system as given by another paper at the same meeting. 1800 w. Eng News—Oct. 1, 1903. No. 58180.

NEW PROJECTS.

Colombia.

Colombian Railway Concession to Americans. Report of a concession granted for the construction of a railroad connecting the capital, Medellin, with the lower reach of the Magdalena River and with the Department of the Cauca. 800 w. U S Cons Repts, No. 1772—Oct. 12, 1903. No. 58292 D.

Genoa.

New Connections to the Harbor of Genoa (Neu Abfuhrleinen des Hafens von Genua). E. Bavier. A discussion of the existing railway connections between Switzerland and Northern Italy and the port of Genoa, with suggestions for their extension. Three articles. 4000 w. Schweiz Bauzeitung—Sept. 26, Oct. 3, 10, 1903. No. 58556 each B.

Mountain Railways.

The Wildstrubel and Lötschberg Railways (Die Wildstrubel und die Lötschbergbahn). A discussion of the proposed railways for the connection of the Bernese Oberland with the Simplon. 1800 w. Schweiz Bauzeitung—Sept. 19, 1903. No 58555 B.

South Africa.

The Railways in Our New South African colonies. A review of the report of T. R. Price, on the working of the Central South African railway. 3300 w. Engr, Lond—Oct. 9, 1903. No. 58440 A.

Transcontinental.

The New Canadian Transcontinental Railway. An account of this important railway project, with maps. 9800 w. Eng News—Oct. 22, 1903. No. 58633.

The Transcontinental Railway. W. H. James. A statement of reasons which justify the construction of a railway from Kalgoorlie (W. A.) to Port Augusta (S. A.). 2800 w. Aust Min Stand—Sept. 10 & 17, 1903. 2 parts. No. 58604 each B.

PERMANENT WAY AND FIXTURES.

Auxiliary Tanks.

On the Use of Auxiliary Tanks for Increasing the Rate of Supply of Water Cranes. Ch. Coda. Illustrates and describes the system which has been successfully applied on the Rome-Pisa line. also a report on means for preventing the freezing of water in water supply installations, and economic methods for keeping water in tanks at constant temperature. 2200 k. Bul Int Ry Cong—Sept., 1903. No. 58272 E.

Broad Gage.

Brunel and the 7-Ft. Gage. Herbert T. Walker. Reviews the engineering works of Isambard Kingdom Brunel, and gives an account of the 7-ft. gage laid for the Great Western Railway of England. Ill. 3000 w. R R Gaz—Oct. 16, 1903. No. 58400.

Cut-Off.

The Brilliant Cut-Off of the Pennsylvania Railroad at Pittsburg. Illustrated description of an important change to relieve the congestion of freight traffic at Pittsburg. 700 w. Ry Age—Oct. 16, 1903. No. 58447.

Improvements.

Norfolk & Western Road Improvements. George L. Fowler. An illustrated article, describing improvements in grades and alignment. 1800 w. R R Gaz—Oct. 2, 1903. No. 58266.

Recent Improvements on the Oregon Short Line R. R. W. P. Hardesty. An illustrated article describing trestles, bridges, &c., recently built, and improvements in roadbed, grades and curves. 2500 w. Eng News—Oct. 15, 1903. No. 58402.

Signals.

Experiments with the Krizik Block Signal System (Die Versuche mit der Blocksignale System Krizik). A. Prasch. Tests made on the Austrian State Railways with the Krizik system of automatic electric signals, operating by a contact made by the train. 3500 w. Zeitschr d Oesterr Ing u Arch Ver—Oct. 9, 1903. No. 58535 D.

Power Signalling. Brief illustrated description of an installation at York, England, on the North Eastern Railway Electric power is used. 800 w. Elec Engr, Lond—Oct. 16, 1903. No. 58497 A.

The New Collective Long Distance Signal System (Die Versuche mit der Leviers d'Itineraires pour la Commande à Distance des Aiguilles et Signaux de Chemins de Fer). G. Bleynie. A detailed description of the Bleynie and Ducousso system, recently installed on the Chemin de Fer du Midi. 15000 w. 7 plates. Rev Gen des Chemins de Fer—Oct., 1003. No. 58536 H.

Stations.

New Stations on the Grand Trunk. Illustrations and brief descriptions of stations at Portland, Me., and at Flint, Lansing and Durand, Mich. 800 w. Ry Age—Sept. 25, 1903. No. 58117.

Terminals.

Improvement of Railway Terminal Facilities at St. Louis, Mo. Abstract of a committee's report considering needed improvements. 2500 w. Eng News—Oct. 29, 1903. No. 58679.

Track Laying.

The Improved Harris Track-Laying Machine. Illustrated description of the machine and its operation. 3300 w. Ry & Engng Rev—Oct. 10, 1903. No. 58376.

Track Tools.

Track Tools—Their Use and Abuse. From a paper by J. C. Rockhold, read before the Roadmasters' and Maintenance of Way Assn. The need of instructing men in regard to the proper use and care of tools, citing cases of bad practice. 2000 w. Ry & Engng Rev—Oct. 17, 1903. No. 58610.

Tracks.

General Track Work. From a paper by A. Morrison, read before the Roadmasters' and Maintenance of Way Assn. The importance of good drainage, good material, and various other points are considered. 1800 w. Ry & Engng Rev—Oct. 17, 1903. No. 58609.

Track Construction and Maintenance. Thomas W. Wilson. Read at Syracuse meeting of the N. Y. State St. Ry. Assn. Discusses rails, joints, roadbed and paving, &c. 2200 w. St Ry Jour—Oct. 17, 1903. No. 58455 C.

Vesuvius.

The Vesuvius Railway (Le Chemin de Fer du Vésuve). A general description of the new railway from Naples to the funicular railway at the crater of Vesuvius. 5000 w. Rev Gen des Chemins de Fer—Oct., 1903. No. 58537 H.

Yards.

Norfolk and Western Yard Improvements. George L. Fowler. An illustrated article outlining the work undertaken. 3800 w. R R Gaz—Sept. 25, 1903. No. 58140.

MISCELLANY.

Eastern Europe.

The Railways of Dalmatia, Bosnia, and Herzegovina (Die Eisenbahnen von Dalmatien, Bosnien, und Herzegowina). J. R. V. Wenusch. A general descriptive account of the railway systems of the Balkan states, based on a tour of observation. 5000 w. Zeitschr d Oesterr Ing u Arch Ver—Sept. 18, 1903. No. 58532 D.

New Zealand.

New Zealand Railways. Editorial review of the annual report of these railways. 1800 w. Engng—Oct. 2, 1903. No. 58297 A.

Taxation.

Taxation of Freight Car Lines. Editorial discussion of some of the plans for taxing car lines now in vogue in the United States. 1800 w. Ry Age—Oct. 2, 1903. No. 58226.

STREET AND ELECTRIC RAILWAYS

Accounts.

The Province of the Street Railway Accountant. Henry W. Brooks, Jr. On the importance of the accountant's work, and some of the statistics needed by the general manager, with suggestions. 3500 w. St Ry Rev—Sept. 20, 1903. No. 58131 C.

Alpine Railways.

The Service of Electricity in Climbing the Alps. Frank C. Perkins. Brief illustrated description of the Jungfrau and other mountain railways. 900 w. Sci Am Sup—Oct. 31, 1903. No. 58682.

Australia.

The Electric Tramways of Kalgoorlie, Western Australia. S. W. Childs. Brief description of a line for a city of about 30,000 people. 1600 w. Elec Rev, N Y—Oct. 24, 1903. No. 58622.

Bexley.

The Bexley Electric Tramways and Electric Lighting. Illustrated description of a recently inaugurated system in England. 2000 w. Elec Engr, Lond—Oct. 2, 1903. No. 58278 A.

Budapest.

Electric Railways of Budapest. Franz Köster. Illustrated description of the electric underground and surface railways and power plant construction. 2000 w. St Ry Rev—Sept. 20, 1903. No. 58128 C.

Claim Department.

Claim Department Methods in Brooklyn. George R. Folds. Gives a description of the reports required and the methods in use, with comments on this important work. 2300 w. St Ry Jour—Oct. 3, 1003. No. 58246 C.

Compressed Air.

Mekarski System of Compressed Air Locomotives as Used on Suburban Lines in Paris. Illustrated description of this system. 1600 w. Sci Am Sup—Oct. 17, 1903. No. 58414.

Crossings.

Steam and Electric Railway Crossings. Charles R. Barnes. Read at Syracuse meeting of the N. Y. State St. Ry. Assn. Discusses grade crossing accidents and the best protection when the crossing is at grade. 2000 w. St Ry Jour—Oct. 17, 1903. No. 58458 C.

Denver.

Denver Tramway System. An illustrated detailed description of the new station of the Denver Tramway Power Co., and the high-tension transmission, and other features. 7500 w. St Ry Jour—Oct. 10, 1903. No. 58334 C.

Economics.

Economic Considerations Determining the Magnitude and Details of a Proposed Road. From advance proofs of "Electric Railway Economics," by W. C. Gotshall. 3000 w. St Ry Jour—Oct. 10, 1903. No. 58335 C.

Electric Locomotives.

Electric Mine Locomotives for Narrow Gauge (Elektrische Grubenlokomotiven für Schmalspur). Ernst Egger. Illustrated description of 3 ton electric locomotive for 488 millimetre gauge for the coal mines at Fünfkirchen, Hungary. 2000 w Elektrotech Zeitschr—Oct. 1, 1903. No 58565 B.

Electric Traction.

An Important Step in Electric Traction. Information concerning an experiment in progress on a suburban line near Berlin. The trial of a new motor, invented by an Austrian electrician, deriving its energy from a single-phase alternating current of 6,000 volts, delivered directly to the motor, apparently with entire success. Ill. 700 w. U S Cons Repts, No. 1769—Oct. 8, 1903. No. 58241 D.

Engine.

The Robb-Armstrong Engine for Electric Traction. Illustrated description of an engine much used in Canada and foreign countries. 1800 w. Tram & Ry Wld—Oct. 8, 1903. No. 58427 B.

Europe.

Electric Railways in Europe. An account of the recently resumed high-speed trials at Berlin, where a speed of 118 miles an hour was attained. 1500 w. Elec Rev, Lond—Oct. 2, 1903. No. 58281 A.

Fares.

Fares and Fare Protection. John F Ohmer. Abstract of a paper read before the Penn. St. Ry. Assn. Reviews the conditions and describes the Ohmer register and system. 3000 w. St Ry Jour—Oct. 3, 1903. No. 58248 C.

High Speed.

High-Speed Electric Traction at Berlin. Brief review of the trials on the Marienfelde-Zossen line and the great speed attained. Illustration of car used. 1200 w. U S Cons Repts, No. 1783—Oct. 24, 1903. No. 58474 D.

Interurban.

Auburn & Syracuse Electric Railway. An illustrated detailed description of this road and its equipment. Of interest because of the direct competition with steam lines. 2000 w. St Ry Jour—Oct. 3, 1903. No. 58244 C.

Colorado Springs and Interurban Railway System. Illustrated detailed description of the road and equipment. 3500 w. St Ry Jour—Oct. 3, 1903. No. 58245 C.

Freight Development by Interurban Roads. E. F. Seixas. Read at Syracuse meeting of the N. Y. State St. Ry. Assn. An account of the development of this service in Canada. 2300 w. St Ry Jour—Oct. 17, 1903. No. 58459 C.

Interurban Freight and Express. An illustrated article describing the methods of the Electric Traction Co. of Cleveland, 2500 w. St Ry Jour—Oct. 24, 1903. No. 58613.

Interurban Train Dispatching. E. P. Wilcoxen. Read at Syracuse meeting of the N. Y. State. St. Ry. Assn. Describes principally the telephone system of despatching. 1200 w. St Ry Jour—Oct. 17, 1903. No. 58457 C.

Power Transmission for Interurban Lines. J. B. Storer. Read at Syracuse meeting of the N. Y. State St. Ry. Assn. Considers some of the possible improvements that may be made in electrical systems. 2000 w. St Ry Jour—Oct. 17, 1903. No. 58456 C.

The Columbus, London, and Springfield, and the Dayton, Springfield and Urbana Railways. H. C. Reagan. An illustrated detailed description of a fine interurban system in Ohio. 7000 w. St Ry Rev—Sept. 20, 1903. No. 58130 C.

The Utica & Mohawk Valley Railway. Illustrated description of an important electric railway system in Central New York. 9300 w. St Ry Rev—Oct. 20, 1903. No. 58660 C.

Main-Line Traction.

Steam or Electricity? (Dampf oder Elektrizität). Alfred Birk. A comparison of steam and electric power for the future attainment of high speeds on main-line railways, showing the possibilities of the latter. 5000 w. Oesterr Monatschr f d Oeff Baudienst—Oct. 10, 1903. No. 58578 D.

Multiple Unit.

The Multiple Unit System of Electric Traction (La Traction Elektrique et les Trains à Unités Multiples). Jean de Traz. Discussing the extending use of the multiple-unit system in the United States, and showing its applicability to local transport in France. 10000 w. Mem Soc Ing Civ de France—Aug., 1903. No. 58573 G.

New Zealand.

Electric Tramways in Auckland, New Zealand. Illustrated detailed description of an extensive system. 1300 w. St Ry Jour—Sept. 26, 1903. No. 58121 C.

Operation.

Hydraulics in Connection with Street Railway Operation. C. E. Parsons. Read at the St. Ry. Con. at Syracuse. Especially discusses the plants at Spier Falls and Mechanicsville, and their economy and reliability. 1500 w. St Ry Jour—Oct. 10, 1903. No. 58336 C.

Railway Motors.

Some Notes on the Operation of Railway Motors in Service. Clarence Renshaw. On the means of determining whether the loads carried by the motor are within its capacity. Results of actual tests, explaining method of equating the service loads. Also discussion. 7000 w. Trans Am Inst of Elec Engrs—June, 1903. No. 58617 D.

The Conditions Governing the Rise of Temperature of Electric Railway Motors in Service. Cary T. Hutchinson. A report of investigations made developing a method for determining the performance of any motor in service. 5700 w. Trans Am Inst of Elec Engrs—Oct., 1903. No. 58620 D.

Reports.

System of Reports of Denver City Tramway. Explains the extensive system in use, giving forms of blanks and general information. 3000 w. St Ry Jour— Sept. 26, 1903. No. 58122 C.

Switzerland.

Mountain Electric Road in Switzerland and the Sublin Hydraulic Plant. C. L. Durand. An illustrated description of the Bex-Gryon-Villars line, equipped on the Thury direct-current system. 3300 w. Elec Rev, N Y—Oct. 10, 1903. No. 58338.

Trolley Omnibus.

The Trolley Omnibus. Illustrates and describes a type of trolley with self-contained electric motor, invented by Mr. Lombard Gerin. 2200 w. Trac & Trans —Oct., 1903. No. 58381 E.

Tunnel Ventilation.

The Ventilation of Deep-Level Underground Railways. A suggestion. B. Pontifex. Describes a scheme for automatically removing the foul air by suction pipes. 500 w. Elec Engr, Lond—Oct. 9, 1903. No. 58421 A.

Valtellina.

The Valtellina Electric Railway. An illustrated description of this line, which forms part of the Adriatic railway system in Italy. 2800 w. Elec Rev, Lond—Oct. 2, 1903. Serial. 1st part. No. 58282 A.

EXPLANATORY NOTE—THE ENGINEERING INDEX.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* Boston.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Jl. of Science. *m.* New Haven, U.S.A.
American Machinist. *w.* New York.
American Shipbuilder. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. d Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *qr.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Sydney.
Autocar. *w.* Coventry, England.
Automobile. *m.* New York.
Automobile Magazine. *m.* New York.
Automotor & Horseless Vehicle Jl. *m.* London.
Beton und Eisen. *qr.* Vienna.
Brick Builder. *m.* Boston.
British Architect. *w.* London.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bulletin American Iron and Steel Asso. *w.* Philadelphia, U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. Soc. Int. d Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Montreal.
Canadian Mining Review. *m.* Ottawa.
Cassier's Magazine. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Electrical Engineer. *w.* London.
Electrical Review. *w.* London.

Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Electrochemical Industry. *m.* New York.
Electrochemist and Metallurgist. *w.* London.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Chicago.
Engineering. *w.* London.
Enginering and Mining Journal. *w.* New York.
Enginering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penna. *m.* Pittsburg, U.S.A.
Feilden's Magazine. *m.* London.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland, U. S. A.
Gas Engineers' Mag. *m.* Birmingham.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e. d. Str. Ferr. *w.* Rome.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Ice and Refrigeration. *m.* New York.
Ill. Zeitschr. f. Klein u. Strassenbahnen. *s-m.* Berlin.
Ingeneria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron and Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. Am. Foundrymen's Assoc. *m.* New York.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Journal of Sanitary Institute. *qr.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery *b-m.* Fort Monroe, U.S.A.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U.S.A.
Locomotive. *m.* Hartford, U. S. A.
Locomotive Engineering. *m.* New York.
Machinery. *m.* London.
Machinery. *m.* New York.
Madrid Cientifico. *t-m.* Madrid.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Metallographist. *qr.* Boston.
Metal Worker. *w.* New York.
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* City of Mexico.
Minerva. *w.* Rome.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci Press. *w.* San Francisco.
Mining Reporter. *w.* Denver, U. S. A.
Mitt. aus d Kgl Tech. Versuchsanst. Berlin.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Modern Machinery. *m.* Chicago.
Monatsschr. d Württ. Ver. f. Baukunde. *m.* Stuttgart.
Moniteur Industriel. *w.* Paris.
Mouvement Maritime. *w.* Brussels.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *m.* New York.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Nineteenth Century. *m.* London.
North American Review. *m.* New York.
Oest. Wochenschr. f. d. Oeff Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg- & Hüttenwesen. *w.* Vienna.
Ores and Metals. *w.* Denver, U. S. A.
Pacific Coast Miner. *w.* San Francisco.
Page's Magazine. *m.* London.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Procedings Engineers' Club. *qr.* Philadelphia.
Pro. St. Louis R'Way Club. *m.* St. Louis, U. S. A.
Progressive Age. *s-m.* New York.
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago
Review of Reviews. *m.* London & New York.
Revista d Obras. Pub. *w.* Madrid.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Gen. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Engng. *m.* Ithaca, N. Y.
Stahl und Eisen. *s-m.* Düsseldorf.
Steam Engineering. *m.* Chicago.
Stevens' Institute Indicator. *qr.* Hoboken U.S.A.
Stone. *m.* New York.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago.
Tijds. v h Kljk. Inst. v Ing. *qr.* Hague.
Traction and Transmission. *m.* London.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining. Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
Wiener Bauindustrie Zeitung. *w.* Vienna.
World's Work. *m.* New York.
Yacht. *w.* Paris.
Zeitschr. d. Mitteleurop. Motorwagen Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a S.
Zeitschr. f. Electrotechnik. *w.* Vienna.

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THE SOLUTION OF THE ISTHMIAN-CANAL PROBLEM.

By Gen. Henry L. Abbot.

General Abbot is beyond question one of the foremost authorities upon the physical problems of the Panama Canal—especially the Chagres problem which is the key to the entire project. His study of that question which appeared in this Magazine in December, 1902, was not only (to quote Mr. Morison's expression in a contribution to these pages just one year ago) "of an exhaustive character and of the greatest value." It was more—a complete demonstration of the soundness of the choice of the Panama route as the best for an Isthmian canal.

General Abbot has been so sure of the unassailable strength of this position that he has always chosen to demonstrate it, rather than to enter into controversial discussion of any other route. It is therefore of very great interest, now that the determination is beyond controversy (except probably the assaults of Senator Morgan and others of his type), to have this calm and distinct expression of General Abbot's opinion of the Nicaragua route, judged absolutely and by comparison with that which has been chosen for the great work.—THE EDITORS.

NOW that the smoke of the battle which has so long clouded the projected Isthmian-canal problem has cleared away, it is not without utility to consider the dangers escaped by choosing the route by Panama. For many years this route was considered as pre-empted by France, and the United States could only hope to secure the second best which was believed to be that by Nicaragua. This latter route had been repeatedly examined, and finally, in 1899, with some misgivings on the part of those best informed in the matter, Congress had nearly decided to take decisive action and begin the work of construction. Never was there a more conspicuous illustration of the wisdom of the old adage *festina lente.* Now that the peril is passed, and in the light of the important developments made known since that date by the labors of the Isthmian Canal Commission, we can calmly and without exaggeration consider what sort of a canal we were about to undertake.

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The first point for consideration in judging of the merit of a projected canal is the facility of approach for large vessels. Natural harbors do not exist in Nicaragua, but this statement does not fully cover the case. On the Pacific coast one may be excavated and probably maintained at moderate cost, but on the Atlantic coast a never-ending battle with the forces of nature is inevitable. Fifty years ago a good harbor existed at Greytown, and lines of steamers connected it with New York and New Orleans. Now it has become a lagoon, shut in by the advancing sand movement occasioned by winds and waves acting upon the materials transported in vast quantities by the San Carlos and Serapiqui rivers from the volcanic region where they take their rise. We have learned by experience on the South Atlantic, Gulf, and Pacific coasts of the United States what such a struggle with nature means. Costly works of improvement, annual outlay for dredging, and liability to temporary closure by violent storms such as are not infrequent in this tropical region, must be contemplated.

The general characteristics of the inland district to be traversed next demand attention. Central America has long been the home of volcanoes. Lake Nicaragua itself owes its separation from the Pacific, and its elevation to a height exceeding 100 feet, to some convulsion of a former geologic age. The earthquake of 1844 raised upon it waves which caused immense damages on the banks; and ships following the canal route must pass in the close vicinity of an active volcano, Ometepe, which had a violent eruption in 1883. We have recent and conclusive evidence as to the lack of stability of the earth crust at San Jose de Costa Rica, about sixty miles from the eastern locks of the projected canal, furnished by the reports of the Director of the Institute Fisico-Geografico, there established. From January 1, 1901, to September 30, 1903, a period of 33 consecutive months, these official records show 39 slight tremors, 73 slight shocks, and 33 strong shocks, the decided movements continuing for 14 minutes and 43 seconds. Similar observations made at Panama for the same period show 6 slight tremors and 3 slight shocks, the movements continuing for about 10 seconds. The delicate adjustments of the lock gates of a ship canal are liable to injuries from such movements, entailing delays in transit, while the more violent disturbances which have recently occurred in other parts of Central America could hardly fail to close a canal for long periods. Common sense dictates that the canal should not be placed in the region of greatest danger from earthquakes to be found any where upon the continent, when a safer and better route exists elsewhere.

But there are other general characteristics of the region traversed by the Nicaragua route which show it to be ill suited to the transit of ocean shipping. Such are the strong trade winds that sweep through the gorge of the San Juan river at all seasons of the year. The difficulty in directing the ship would be further increased by the phenomenal rainfall near the Atlantic coast, where it is greater than at any other point on the American continent. The annual average is from 260 to 270 inches, and 25 feet are of record at Greytown, where there is no definite dry season; rain may be expected any day in the year. In the western or lake section the rainfall is much less, being annually about 65 inches, and favored by a well defined dry season. The safety of ship-canal navigation is largely dependent on clear vision, especially by night, and this the conditions existing near the Atlantic coast certainly do not favor. Another serious difficulty would result from the fact that ships must follow the tortuous course of the San Juan river for nearly 50 miles, and although the Isthmian Canal Commission has given careful study to the subject it has been found impossible to reduce the curvature to the limit that experience on the Suez canal has shown to be demanded for easy transit. Furthermore, the channel of the river must carry to the sea all the drainage of about 12,000 square miles of territory, causing at times currents prejudicial to navigation, and complicated by eddies at the mouths of the principal tributaries, of which the Sabalos river is the most important. In fine, then, this long river route, exceeding in length the entire distance from ocean to ocean by the Panama line, must remain subject to the combined effects of strong winds, sharp curvature, and longitudinal and cross currents, to say nothing of the obscuration due to heavy rainfall. It may well be doubted whether any system of artificial lighting could render night transit safe for large ships, and without it delays and possible congestion could hardly be avoided.

No little stress has been laid by the advocates of the Nicaragua route upon the advantages furnished by the great lake that forms a part of it for about 70 miles. The fact has been ignored that about 29 miles of this distance lie through an artificial channel to be excavated in soft mud, where supplementary dredging may often be required; and that about a mile and a half of the western portion must be blasted through rock. The cost of opening this part of the route has been estimated by the Isthmian Canal Commission at nearly $8,000,000, and the chances of touching bottom when the ships are subject to the strong winds and waves that prevail on the lake may well be considered.

But it remains to consider what from an engineering point of view would be perhaps the most serious objection to the Nicaragua route if completed and opened to traffic. This would be the risk of longer or shorter interruptions liable to result from the complicated system of water supply in seasons of drought of long duration, and the lake lies in a district where they are far from uncommon. It has been claimed that a vast lake about 3,000 square miles in extent must furnish an ideal source of supply, but the matter will bear a little examination. By the dam on the lower San Juan river the channel of the present stream would be transformed into an arm of the lake, maintained sensibly at the same level, and through this arm all shipping must pass, the depth of water depending wholly on the stand of the lake. This stand is now subject to a natural oscillation of about 13 feet. Under the projected conditions the entire outflow must pass over the dam at a distance of about 50 miles from the main lake, and if the level is allowed to rise above the present high-water stand, valuable lands under cultivation on the west shore of the lake would be flooded and claims for damages would result. On the other hand, the bed of the river is crossed by many ledges of rock, and the cost of excavation fixes a limit to the practicable depth. The matter was ably discussed by the Isthmian Canal Commission and the conclusion was reached that the natural oscillation of 13 feet must be reduced to rather less than 7 feet. The level of the lake must be held approximately between 111 feet and 104 feet above tide, and the bed must be excavated sufficiently to afford a sailing depth of 35 feet at all times. But the records establish that years of high lake and years of low lake follow in no regular succession. As it is impossible to provide a reserve sufficient to control the level of an immense body of water 3,000 square miles in extent, the regulation of this vital element must be left to the foresight and good judgment of the operator controlling the outflow at the dam. The uncertainties under which he would labor are clearly set forth in the report of the Isthmian Canal Commission.

> "The preceding results obviously can not be considered finally conclusive as to what may happen in regulating the lake in the manner desired, for the reason that a larger monthly rainfall than that corresponding to 16.7 inches at Grenada may occur in October of any year, or in any other month following preceding rainy months which have left the ground in a saturated condition. Concurrent rainfall and lake-stage records are not sufficiently extended to afford a demonstrative treatment of this part of the question."

Carelessness, or bad judgment on the part of the operator at the dam, or an abnormal season, might therefore involve the stoppage of traffic for an indefinite period. A really desirable canal should be subject to no such contingency.

In reference to the technical difficulties of construction little need be said, now that the work is no longer contemplated. Although the dam on the San Juan river has been considered "feasible" by good engineers it is certain that no such construction has ever been executed. To sink a long, continuous, and water-tight row of pneumatic caissons upon the rock bottom, at the extreme practicable depth of operation, below the bed of a river that cannot be diverted, and where the work is liable to be deeply submerged by floods, whether in the San Juan or the San Carlos, is certainly neither an easy nor a safe operation. But the dam is not the only technical conundrum. The deep excavation at the Culebra, on the Panama route, has been so much discussed that the difficulties of similar work in Nicaragua have not attracted the attention that they deserved. The Senate Committee on Interoceanic Canals was informed by one of the members of the Isthmian Canal Commission: "The cut at Tambercito is in hard rock, and while it is deep there is no trouble about that. The conditions are favorable; but at these other two places the conditions are not favorable, and we find that underneath the rock there is a layer of clay. In one place we go through rock twice in our borings and then strike clay in the prism of the canal. That is not an ideal condition of affairs. The Culebra cut is a long one, but the material there is thoroughly understood now." * * "I would rather take the Culebra." Another member laid stress upon difficulties of another character: "I think that swampy country between Greytown and the San Juan River is going to be a very difficult country to work in. It is practically a continuous swamp." * * "It is about 40 miles, practically." * * "It is a swamp throughout. There are no roads in it. You cannot make any roads except by hauling in material to make them. There have never been any, and there is a good deal of timber in that swamp. How much of it is below water I do not know. I do not think we have any idea; but there is, in my mind, a very uncertain element as to how much timber you will find to interfere with your dredges while working in that swamp." * * "A good deal of it is ooze—soft. It is perfectly natural that there should be a swamp in a country of such excessive rainfall."

It should be carefully borne in mind that the language of the law under which the Isthmian Canal Commission was required to act called for information respecting "the most feasible and practicable route" without demanding an opinion as to the absolute merits of the canal when opened to traffic. The Report nowhere states that a Nicaragua canal completed according to the project would furnish a fully satisfactory transit route, capable of competing on favorable terms with that by Suez. The fact that they estimated the annual cost of operation and maintenance at $1,300,000 more than at Panama sufficiently indicates that they appreciated its inherent defects in rejecting it.

It remains to apply this test of practical utility to our contemplated canal by way of Panama. In the important element of natural harbors the route has met all the requirements of commerce during the four centuries since its discovery. On the Pacific, when the canal reaches deep water, no works of harbor improvement will ever be required. On the Atlantic, the natural depth now meets the needs of ordinary commercial steamers, and when more is required it may be secured by dredging, without fear of deterioration, since there are no moving sands to be combated.

The merits of the inland route are equally conspicuous. The distance is only about 45 miles from ocean to ocean, or only one quarter as long as that by Nicaragua, and the summit level may be fixed at about 65 feet, or a little more than half that at Nicaragua. The route is swept by no strong winds; the curvature is exceptionably favorable as compared with existing ship canals; the annual rainfall ranges from about 140 inches on the Atlantic coast, to about 93 inches in the interior and about 60 near the shores of the Pacific, with a well defined dry season of fully three months; and with judicious regulation of the Chagres river there will never be objectionable currents in any part of the route. The transit from ocean to ocean may be made in a single day without encroaching upon the night, but night passages can be made easy and safe by a system of electric lighting supplied by water power at the two dams on the Chagres. The floods of the river may be readily controlled, and ample provision to meet the low-water requirements of the canal may easily be made. In a word, an excellent canal well suited to the needs of navigation may be constructed; there are no technical difficulties that will not yield to the ordinary resources of modern engineering, if judicious measures are adopted in preparing the final plans. It is true that five locks will be required, two to reach the summit level, two to descend, and one to overcome the large tidal oscillation on the Pacific coast; but experience on the Manchester Ship Canal has demonstrated that they will entail no serious difficulties in navigation. It has been claimed that they may be avoided by constructing a tide-level canal, but no demonstration has yet been made that the regulation of the Chagres river under these conditions will not introduce features far more objectionable than modern locks.

It may be interesting to refer to the three objections which have been raised by the advocates of the Nicaragua route. These are the greater distance from our Atlantic and Gulf ports to San Francisco; the obstacle to the passage of sailing ships caused by uncertain winds in the Gulf of Panama; and lastly the health question.

As to the first, the objection is apparent rather than real, since the time lost on the longer sea route will be fully compensated by the gain in time required to traverse the canal, to say nothing of the saving in cost due to lower insurance rates, which will probably be only about one fourth as much as by Nicaragua.

Sailing ships would require towage throughout the entire extent of the Nicaragua route, and the same distance at Panama would carry them nearly or quite to a point where winds might be expected. It is true that the winds in the Gulf of Panama are uncertain, but sailing ships have used the route for hundreds of years, finding it to be the best for trans-shipment of their cargoes across the Isthmus.

In the matter of health the route by Panama enjoys an unenviable notoriety, but it must not be forgotten that the record has been largely aggravated by the disturbance of the surface soil in the construction of the railroad and the canal. As the excavations have now passed through this layer, and have reached the much less dangerous soil below, a marked improvement may be expected, especially when the requirements of modern sanitary science are rigidly observed. In fact, the actual experience of the New Panama Canal Company more than justifies this expectation. The medical director of the fine Company hospital near Panama reported in 1902: "Considering the average figures for the last four years, I find that with a personnel of 2,275 the percentage of disease has been 29.65, and the mortality 2.35 per cent. These figures do not exceed those on large works in any country." After our good work accomplished in Havana we may count on an equal success on the Isthmus. The apparent superiority of the conditions in Nicaragua is probably due in no small degree to the absence of population between the lake and the Atlantic coast.

In fine, now that the problem has been thoroughly studied, and that the facts are known, and that fortune has enabled us to secure the better route, we have good reason to rejoice that hasty action was delayed, and that no mistake has been made in the selection.

ORGANIZATION AND PERSONNEL IN THE BUILDING OF THE PANAMA CANAL.

By Fullerton L. Waldo.

Mr. Waldo, through the association of his father, Dr. Leonard Waldo, with Mr. George S. Morison, and his own association with their office, was in close touch with Mr. Morison during his work on the Canal Commission, and in full possession of Mr. Morison's personal and professional views regarding that work. Their spirit and influence are infused into the following article. It is a short and timely outline of the practical aspects of the construction of the Isthmian Canal.

Probably the strongest and most urgent suggestion which follows its reading is that it is vitally important the President should exercise the very utmost of wisdom, judgment, and courage in his appointments to the Commission which will have charge of the construction work. It demands engineering talent, executive capacity, unshakable integrity, and personal force—all of heroic mould. And every influence that can be exerted should rally to support the Administration in seeing that no one who does not fill this type is given a place on the Commission.—The Editors.

IN spite of the 1,163,000 words spoken against it by Senator Morgan, the Panama Canal is now sure to be built. The past and present history of the project of interoceanic communication is a matter of written record, if one knows where to look; statisticians have busied themselves with forecasting the commercial future of the canal in illusory terms of the net tonnage; the present article is restricted to the prospect from the point of view of the human agent who is to do the actual work of digging and keeping open "the big ditch."

Colon, where the canal begins, on the Caribbean side of the Isthmus, is no place for a white man. It is just an assemblage of mean dwellings and buildings for the railroad, having a population of only a few hundred, without drinkable water or eatable food. A member of the Isthmian Canal Commission would have liked to see the place burned up, and rebuilt on higher ground. The whole Isthmian region has been destitute of drainage for four centuries. What has been done at Santiago de Cuba and at Havana must be repeated here. Colon must be either wiped off the map or cleaned up.

We now know how to mitigate, if not utterly abolish, tropical diseases of the commoner sorts—yellow fever, typhoid, dengue, cholera, malaria. The part the mosquito plays as a "peddler" of malaria germs is realized—as Dr. Howard's book bears scientific witness. A course of lectures was delivered before the students of Jefferson Medical College in Philadelphia by Surgeon Charles F. Kieffer, U. S. A., on the less common types of tropical disease—the various devilish sorts of tropical fevers that gallop a man to his grave; dysentery, abscess of the liver, intestinal parasites, and the rest of the unpleasing category. These lectures are published in the Philadelphia *Medical Journal*, beginning with the issue of January 24, 1903. They are important as being the first systematic instruction with regard to the subject in the United States.

While the earth is turned up to sun and rain along the whole line of the canal works between Colon and Panama is the period when these various diseases will especially get in their deadly work. The Panama Railroad Company tried workingmen of every clime, when the road was being built, and found that the Jamaica negro was the only man who could stand it. "The Chinese rotted," says one engineer, describing his difficulty in getting laborers to build a railway in Costa Rica; "you have to use the Jamaica nigger for that sort of thing." The latter is a "big, black, bounding beggar," sure to go roaring drunk on pay-day. That is one reason why the United States Government must thoroughly police the canal. White men will "boss," and control the highly specialized excavating machinery; but the pick-and-shovel digging is to be done by men whose intelligence is little, if any, removed above that of the brute—and men who are "as lazy as they dare to be."

It is a huge lie that "a life was laid down for every tie of the Panama Railway." Nobody knows just how many Austrians, Irish, Frenchmen, or coolies died, or just how many carloads of "niggers" were dumped out on the flanks of Monkey Hill for superficial burial; but there are more than a hundred thousand ties in the Panama Railway, and there has never been more than a sixth of that number of men at work, even when the Panama Canal Company were conducting the members of the Isthmian Canal Commission on a tour of observation, with a view to making a sale to the United States Government. The old machinery of the French Company is not good for much at present. The American engineers on the whole would rather not have it there. Some of the devices are obsolete; of many, the use has remained undiscovered; probably some of the machinery was built only to sell to the contractors. The United States Government will find it advantageous to install a practically brand-new working plant. Furthermore, the French in their day knew not the possibilities of applied electricity; there is certainly no nation better qualified than the United States to realize these possibilities now in the work of excavation. And the use of electrical power, created by the abundant water-sources, will diminish the number of skilled white laborers required. There must be a number of new types of machinery invented in this connection. The late lamented George S. Morison says, referring to the *crux* of the whole work, the Culebra cut:—

> "No work has ever been undertaken on which the highest class of practical engineering talent could produce so great economies as in this particular great concentrated excavation. The Isthmian Canal Commission estimated the cost of this excavation at 80 cents per cubic yard; bad management would quickly raise this to a dollar, and it is not impossible that with a carefully considered equipment the cost could be reduced to 60 cents. In this single cut, $25,000,000 is an easy measure of the difference between competent and incompetent management." [*Proceedings of the American Society of Civil Engineers*, January, 1903.]

In building the Bohio dam, to form Lake Bohio, the summit level of the canal, caissons must be sunk to a depth of 128 feet, and here, again, enters the human factor. Pneumatic work has hitherto not been carried on at a depth below the surface exceeding 110 to 115 feet. The additional depth means an atmospheric pressure greater by five or six pounds to the square inch. The unprecedented depth has frightened some engineers from the project. Professor William H. Burr, of the Commission said in a hearing before a Congressional subcommittee [February 21, 1902]:—

> "The depth of 128 feet is greater than has yet been reached by the pneumatic process of constructing foundations, the process ordinarily used in such work; but there are methods of reaching that great depth which are entirely feasible. The physical features of the situation are such at Bohio that I am perfectly confident, from my own experience in engineering work, the foundations of that dam can be put in place without using air pressures higher than those which have been encountered in other works."

The caissons of the new East River Bridge went down to a depth of 115 feet; the depth in the case of the Eads Bridge at St. Louis was about the same. A man cannot work more than an hour at this depth. The avoidance of the necessity for frequent relays in this pneumatic work is one of the problems to be solved by the canal engineers; and here, again, is a chance for American inventive genius to meet the occasion with wholly new devices.

Thirty thousand men, it is said, will be wanted for the actual digging of the canal. But no one can authoritatively say at present just how many men will be needed. Ere the real work of building is reached, two preliminary years must be spent in getting ready exact and accurate engineering specifications, in providing a supply of drinking water along the route—a huge and all-important, but perfectly feasible, undertaking—in arranging to enforce police and military regulations, in developing the existent excellent hospital system, and in the works of sanitative engineering at the termini and along the entire canal strip. After all this has been done, it is supposed the Panama Canal will take eight years to build.

The plan of the Isthmian-Canal Commission for the maintenance and operation of the finished canal, which was not published in their official Report, but which was later introduced at a hearing before a sub-committee of the Senate Committee on Interoceanic Canals, is of interest and significance, now that the fulfilment of the project is assured. While undoubtedly there will be substantial modifications, the estimate expresses the carefully considered conclusions and shrewd judgment of the men who are best qualified to know.

By this plan, the general control is vested in a governor, at Colon. Lately, the foolish saying has been current, and has gained credence, that this governor is "a doomed man." If the United States intended to accept sanitary conditions on the Isthmus as it finds them, the $15,000 salary it is proposed to pay might hardly tempt a capable man to undertake the governorship. But the United States is going to "change all that"; and to our own perfervid imagination a new Ponce de Leon or Alcazar at Colon is one day not impossible.

The Governor will be responsible to a supreme board of five at Washington, who, by the Commission's plan, will have $100,000 a year to spend, and are therefore certain to be pilloried by western congressmen.

Subordinate to the governor's office are six departments—of engineering, transit, medicine, finance, law, and police respectively. The engineer's department will employ a chief engineer at $7,500 per annum; an assistant engineer at $3,000; a chief clerk at $2,000; two draftsmen at $1,500; a clerk at $1,500; a stenographer at $1,500; a messenger at $400; one master mechanic at $3,000; two foremen mechanics at $2,000; ten mechanics at $1,500; ten helpers at $360; one clerk at $1,200; a master laborer at $900, five laborers at $360. Subsidiary shops, general storehouses, and locks will employ about one hundred other individuals, at salaries ranging from $2,400 for the chief storekeeper and for the overseer of the locks, down to $360 for day laborers.

The transit department will have a general superintendent with a salary of $7,500. An assistant superintendent will receive $3,000; there will be also a chief clerk at $2,000, two clerks at $1,500, a stenographer at $1,500; two clerks at $1,200; a surveyor at $1,800; a captain of the port at $2,400; a chief telegrapher at $1,800; a messenger at $400. The superintendent of the Panama Railroad is to be an official of this department, and the sum of $45,000 per annum is set aside for the maintenance of the railroad with a working force not specified, the receipts being relied upon to cover the actual transportation expenses. The captain of the port is to have under him twenty pilots, at $2,000 each, two light keepers at $900, and four sailors to look out for buoys of the channel. This force, with the exception of those connected with the railway, is stationed at Colon. There are under the chief telegrapher eight linesmen at $720 and fourteen operators at $900. At Panama there are also a port captain, a surveyor, two light keepers, two clerks, and four sailors. The pilots are included in the enumeration for Colon. At each of the three locks will be stationed a lock master, at $1,800, an assistant lock-master at $1,200, and twenty-seven others—machinists, foremen, gatemen, linemen, watchmen.

The chief surgeon, in the medical department, is to have a salary of $6,000. The importance of his office cannot be over-estimated. There will be a chief medical inspector, at $3,000, two clerks, and a messenger attached to his staff. It will be necessary to have a quarantine officer at each terminus, at $2,400. Three hospitals, at Colon, Bohio, and Pedro Miguel, will each be provided with a corps of nine nurses and others under an assistant surgeon at $2,000. The general hospital at Panama will require the services of five surgeons, two stewards, twenty nurses, four cooks, ten laborers. The chief surgeon receives $3,600, and the assistant surgeons $2,000.

In the finance department, the treasurer will receive $6,000. He will have under him two collectors at $2,400, and eleven other subordinates at salaries from $2,400 down to $400, the sum which the two messengers receive.

The head of the law department is the solicitor, whose salary is $6,000. To his office are attached three clerks and a messenger. There will be a justice of the peace at Panama as well as at Colon; these officials may be men connected with the canal in other capacities; they are to receive $500 additional pay.

The police department is directly governed by a marshal, at $6,000. To his office are allotted a clerk and a messenger. At each canal terminus is a post comprising a captain at $2,000, two lieutenants at $1,500, twelve sergeants at $1,200, ninety privates at $1,030. For the use of this department, twenty saddle horses are kept, at $250 each, at each post.

It is seen, therefore, that the maintenance of the canal according to the official estimate will enlist the services of at least six hundred and forty-five persons, exclusive of the management of the railway. The complete cost of annual maintenance is about $2,000,000.

It should be remembered that the efficiency of the workingman from the North is decreased by about one-half in the tropical climate. The numbers of workmen needed may easily, therefore, be far in excess of the figures given. It is impossible at a desk many hundreds of miles away to forecast contingencies at the seat of actual operations. But one thing is certain—the Panama Canal can be built and maintained without jeopardizing the health of Americans who are among the toilers in the field. And finally, let me quote Mr. Morison's words in the *Bulletin of the American Geographical Society,* February, 1903.

> "When the canal is built, the malarial spots in the interior will have been replaced by Lake Bohio, and the condition of the Isthmus should be no worse than that of other damp tropical countries. Lake Bohio, surrounded by hills and mountains, will be a beautiful and accessible body of water, traversed by frequent steamers, with all convenient connections with the ports of other countries. The surrounding hills will add beauty to the landscape and furnish sites for gardens and residences. It is not impossible that this region, which has been regarded as one of the world's pestholes, will in time become a favorite winter resort."

THE MARIENFELDE-ZOSSEN HIGH-SPEED ELECTRIC-RAILWAY TRIALS.

By Dr. Alfred Gradenwitz.

The following account of the Marienfelde-Zossen high-speed trials will be of interest in connection with the successful results recently obtained, which aroused a sensation all over the world.—The Editors.

THE Marienfelde-Zossen high-speed electric-railway trials, as is known, were undertaken with a view to obtaining the necessary technical and economical data for a regular electric-railway service up to speeds as high as 200 kilometres per hour. Useful data were available from previous trials made by the Siemens & Halske Company on their special experimental line in Gross-Lichterfelde near Berlin, which line was intended to be a model railway for operation by 10,000-volt currents. It is due mainly to the enterprise of the two leading electric firms in Germany, the Siemens & Halske Company and the Allgemeine Elektrizitäts Gesellschaft,* as well as to the assistance of the most important German banking firms and the authorities concerned, that as early as the fall of 1899 a special concern was formed under the name "Studiengesellschaft für Elektrische Schnellbahnen." The German railway authorities placed at the disposal of the undertaking the Marienfelde-Zossen military railway, and two cars to be constructed respectively by the firms mentioned above were to be used for the experiments.

The Siemens & Halske Company undertook the construction of the line supplying the electric power, whereas the A. E. G. were willing to generate the power in their Oberschönweide electricity works as well as to construct the feeding wires thence to Marienfelde-Zossen. The line was to be constructed after the model of the Gross-Lichterfelde experimental track, and the same arrangement of the conductors and collectors, as well as the same kind of current, namely 10,000 volts rotary current between two conductors, was to be used.

The Marienfelde-Zossen military line, 23 kilometres in length, seemed specially available, as there are no curves of less than 2,000 metres radius the short gradients being not more than 1:200. The permanent way, however, corresponded only with the older types of

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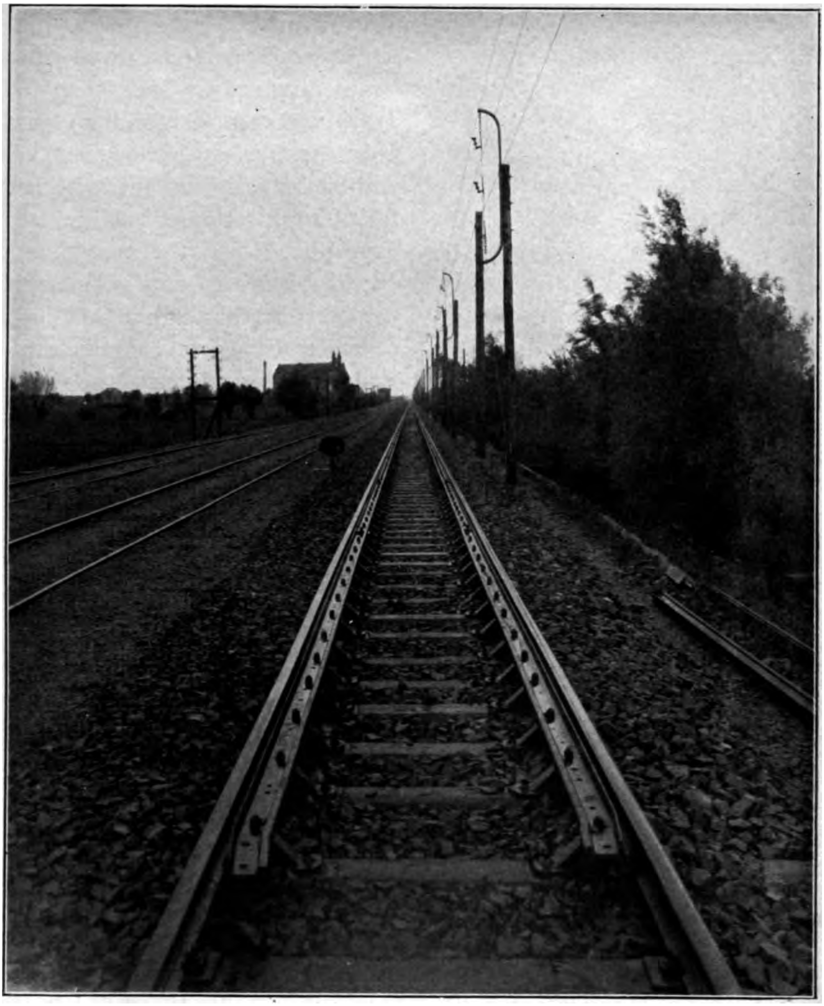
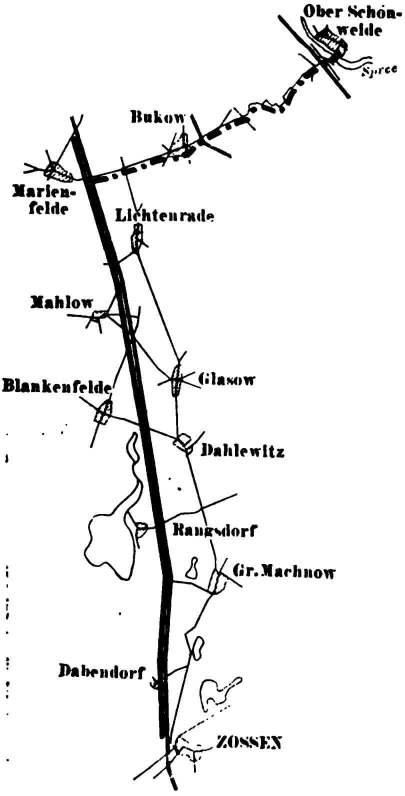
* Familiarly known by the convenient abbreviation "A. E. G.," which is frequently used in this article.



THE MARIENFELDE-ZOSSEN TRACK.

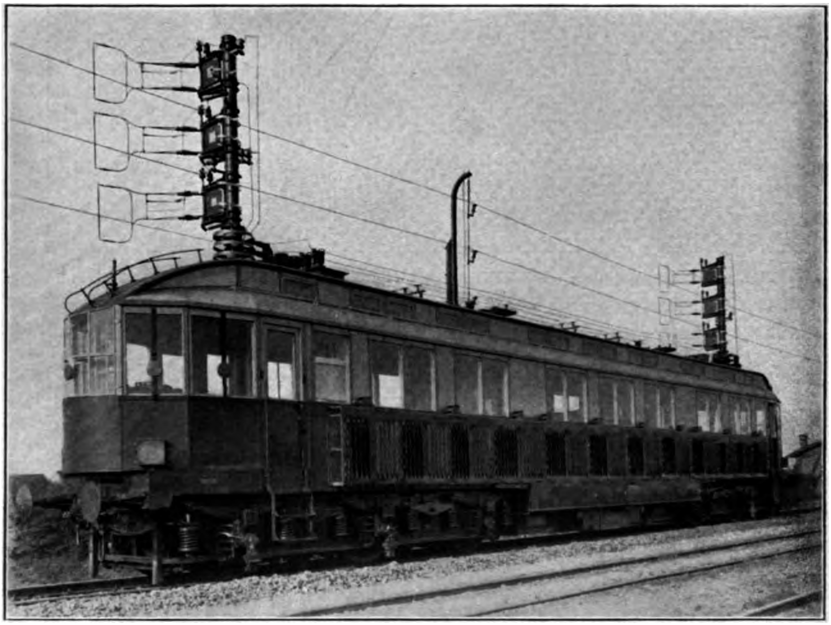
Prussian railways, consisting of light rails of 33.4 kilogrammes per metre (67 pounds per yard), placed partly on wooden sleepers and partly on short iron sleepers, the road bed consisting mainly of inferior material. Though it accordingly was anticipated at the very outset that the existing permanent way would not be sufficiently resistant for maximum speeds as high as 200 kilometres per hour, it was decided to begin the trials without any rebuilding of the track, apart from some immaterial improvements. After the number of sleepers had been somewhat increased, and the road bed re-enforced with consider-



MAP OF THE LINE.

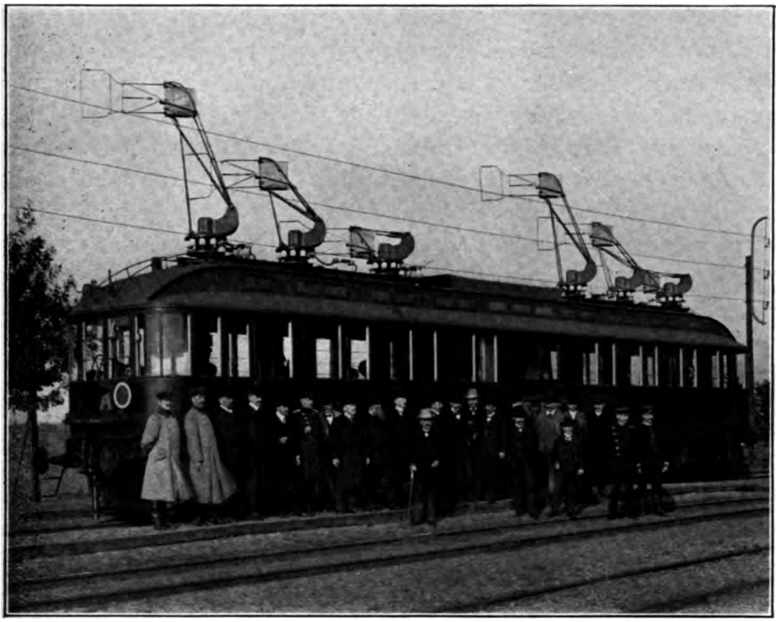
able amounts of broken stone, the track stood perfectly well the strain involved by speeds up to 130 kilometres (80.8 miles) per hour. As, however, in connection with the experiments made in the fall of 1901, serious troubles were experienced for the maximum speeds of 140 to 160 kilometres per hour, a thorough rebuilding of the track was eventually carried out in the course of the summer of 1902. The new rails have a weight of 42 kilogrammes per metre (about 84½ pounds per yard) and a length of 12 metres, being placed on 18 fir sleepers with hard wood pegs; 15,000 cubic metres broken basalt were used for the road bed. About 17 kilometres of the track were fitted with guard rails such as used in connection with ordinary railways on bridges, etc. These guard rails, the foot of which is 50 millimetres distant from the main rail, are fixed on cast-iron beds screwed to every sleeper, this arrangement, in addition to preventing derailments, imparting an extraordinary strength to the whole of the road bed.

The Overhead Line.—The arrangement of the overhead line is shown by the accompanying figures, the middle of the pole being about 2¼ metres distant from the middle of the track and the three horizontal wires conducting the three-phase current being about 1 metre apart. The picture opposite shows the construction. The whole of the line is divided into sections of about 1 kilometre, each of which is provided in the middle with a device for compensating losses in pressure. The neutral point of the system is connected to the earth and to the rails. The suspension point moves aside somewhat as the collector presses against the horizontal wire, a satisfactory and simultaneous contact between the three horizontal wires and the contact arcs being thus possible. This is ensured by having the single parts on the outrigger, intended for carrying the insulators, connected by joints. The horizontal wires have a double insulation against earth, and each insulation separately is susceptible of standing the whole of the maximum pressure of 20,000 volts occurring during the service. The wires have cross sections of 100 square millimetres (0.155 square inch) each, the tension between each two wires varying between 10,000 and 12,000 volts. Hard copper wire with a breaking strength as high as 38 kilogrammes per square millimetre and a conductivity more than 97 per cent. of that of chemically pure copper is used; lightning arresters are provided, as well as safety devices in case of a fracture by which the wire is automatically earthed.



THE SIEMENS & HALSKE CAR USED IN THE MARIENFELDE-ZOSSEN EXPERIMENTS.

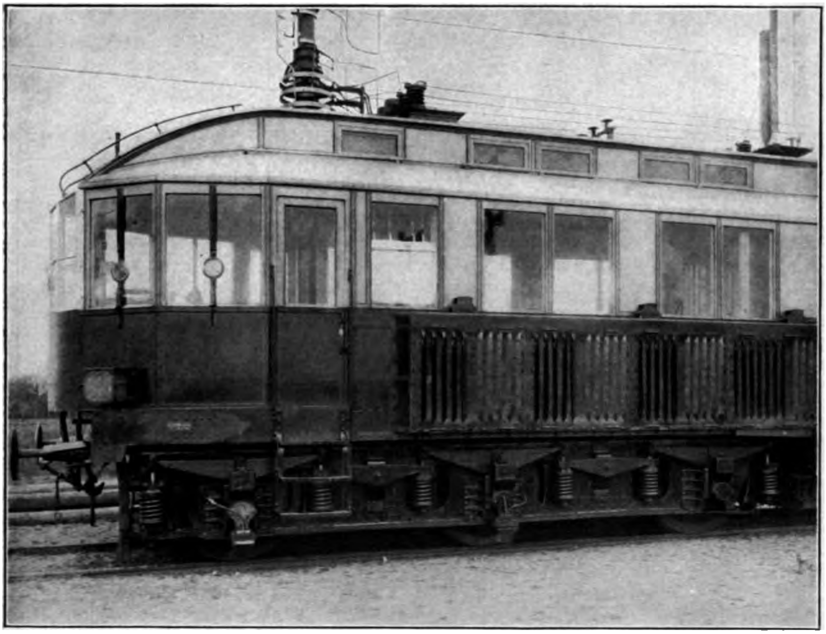
The Collectors.—The collectors are constructed according to the system developed by the Siemens & Halske Company on their Gross-Lichterfelde experimental track; they are nearly identical on both cars, differing only as to the details. In the Siemens' car they have the form of two masts supported by the cars at either end and movable around their vertical axis. These masts consist of two Mannesmann tubes, each about 200 millimetres in diameter, inserted one into the other. By means of a crank acting on a double toothed gearing, any desired rotation of the masts may be effected from the motor-man's



THE A. E. G. CAR USED IN THE MARIENFELDE-ZOSSEN HIGH-SPEED RUNS.
View taken immediately after the successful trials on Oct. 28, when a speed of 210 kilometres (130.5 miles) an hour was attained.

stand. The sliding rings are attached to an insulated tube. Contact springs, screwed by means of hard rubber insulators on a special flat iron frame, are fixed to the three sliding rings. Into the insulating tubes and partly into the lower part of the collector, the upper tube is slipped, so as to be readily dismounted after loosening a few screws. This tube bears, at central distances of 1 metre each, three rotating axles for the contact bows proper. The wind pressure against the bow on one side of the rotating axle is balanced by means of a vane attached to the other side of the axle. The A. E. G. car is likewise fitted with two groups of three collectors each, one for each phase, which however, instead of being placed on one common mast, are arranged one behind the other. Both arrangements have so far given full satisfaction, it being impossible to decide which is the more available. Sparking between the overhead wires and the collector bows, as occasionally noted in connection with the earlier experiments, was recently prevented by some slight improvements in the construction of the collectors. One of the most difficult problems, namely the transmission of high amounts of energy from a stationary conductor to a train running at enormous speeds, has thus been satisfactorily solved.

The Motor Cars.—The two motor cars used with these trials were constructed by Messrs. van der Zypen & Charlier, Cologne-Deutz, in accordance with the electric apparatus supplied by the two electric firms. The cars, intended for about fifty passengers, are 21 and 22 metres in length respectively, and correspond as to their dimensions and equipment with the technical regulations of the Association of German Railway Administrations. The body of the car rests by means of two centre bolts on two trucks without any special springs. In addition there are on the frames of each truck four steps limiting the lateral oscillation of the body by bearing part of the weight of the car. Lateral oscillations of the body were moreover observed only for lower speeds, up to 100 kilometres per hour, whereas with higher speeds the run of the cars was perfectly steady, much more so than with ordinary rapid trains. Each of the trucks is fitted with three axles, the external axles bearing the motor, whereas the central ones serve as running axles. The distance between the axles was at the beginning 3.8 metres; this has been increased up to 5 metres in connection with the recent successful trials. The distance between the centres of each two trucks is 13.3 and 14.3 metres respectively, and the diameter of the wheel tread 1.25 metre. Two springs are placed against the axle



THE TRUCK; IDENTICAL ON BOTH CARS.

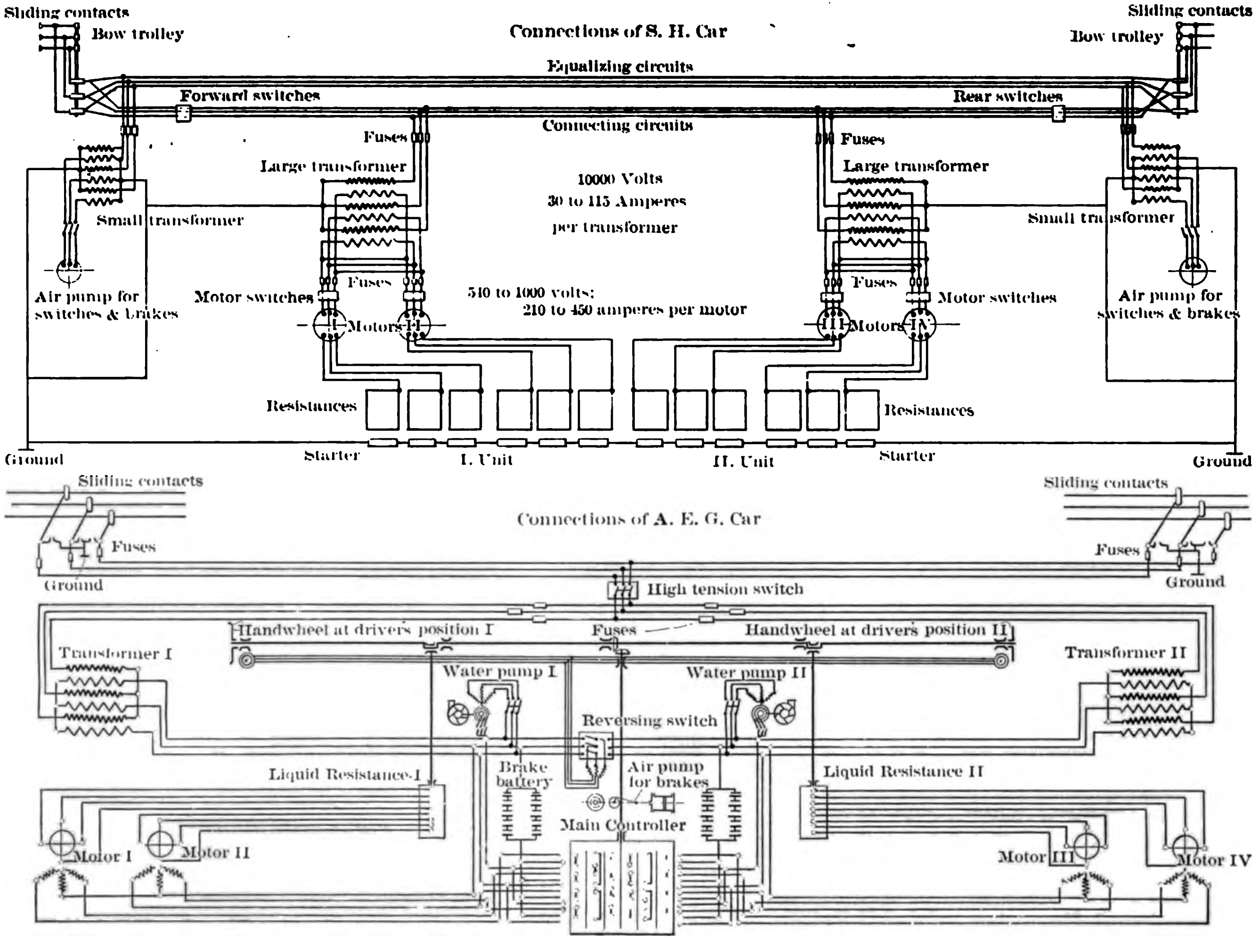


DIAGRAM SHOWING THE CONNECTIONS OF THE SIEMENS & HALSKE AND THE A. E. G. CARS RESPECTIVELY.

boxes, namely one plate spring, 1.5 metre in length above each axle box, these plate springs being in turn maintained at their ends by spiral springs, the tension of which is regulated by means of screws. As the trucks, in connection with the earlier experiments, followed any deviation in the direction of the track, the distance of the wheels as above said was increased to 5 metres and the bearing springs placed so as to be visible and connected with one another by compensating levers. The centre bolts, which formerly were rigidly fixed to the lower frame, were in the course of the recent reconstruction provided with lateral pegs fitted with springs, so as to prevent any transmission of the oscillations of the body to the frame.

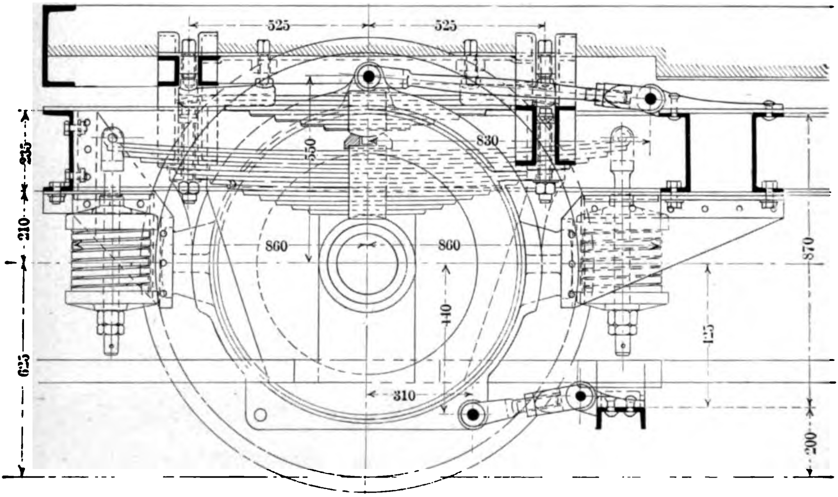
The Connections of the Cars.—The connections of the cars are shown on page 500. In the A. E. G. car, the current is led by means of armoured cables from the two groups of collectors to the main switch in the machine room and thence by separate conductors to the transformers. The main cut-out switch is operated only after the run is completed, or as an emergency switch in case of disturbances occurring during the run. From the transformers the low-tension conductors lead through the main controller to the motors. The main controller is also placed in the machine room of the car, being easily actuated from each driver's stand through a steering wheel connected by toothed gearing to an axle traversing the whole length of the car. This controller directs the working current to the motors and through the resistances, and permits forward and reverse running, besides providing for the braking of the car by means of reverse current. There is in addition a small controller in the driver's stand, conveying low-tension current from the transformer to the motor for operating the air compressor in connection with the compressed-air brake.

The connections in the Siemens & Halske car are somewhat different, the high-tension current being first conveyed to one of the two main switches for forward and backward running, which may be controlled from the driver's stand, and thence to the two large transformers, whence the working current is again conveyed through individual switches towards the motors and the resistances. From the main conductors on the roof of the car, part of the current is in addition branched off towards the small transformer placed above the motor'man's stand, and conveyed to the electric motor operating the two air pumps. Two special cranks are provided in the motor-man's stand for actuating the reversing switch and the motor switch respectively, the working resistances being controlled by the driver through a special controlling wheel with or without the agency of compressed air. These equipments have given satisfactory results with both carriages and proved very effective, affording full protection against the electric current.

Transformers.—The main characteristics of the transformers used in each of the cars are as follows:

In the transformers of the Siemens & Halske car the effective iron sheets are placed vertically on their small edges and distributed in groups, between which there is space for the passage of air. The secondary coil is well insulated from the iron cores, the coils of the primary winding being placed above it. In the ventilating channel of the iron cores, there are protective boxes prolonged as far as the front plates of the casing and expanding into the latter so as to facilitate the drawing in of the air.

The transformers in the A. E. G. car are designed according to the patents of this company with three parallel iron cores, the axes of which run longitudinally. Each iron core is provided with a longitudinal slot through which, as well as between the rectangular cores and the round coil, an air current is allowed to pass. The transformers in both cars have given full satisfaction, the strong air currents proving particularly effective and preventing any considerable heating effects.



SUSPENSION OF THE MOTOR ON THE A. E. G. CAR.

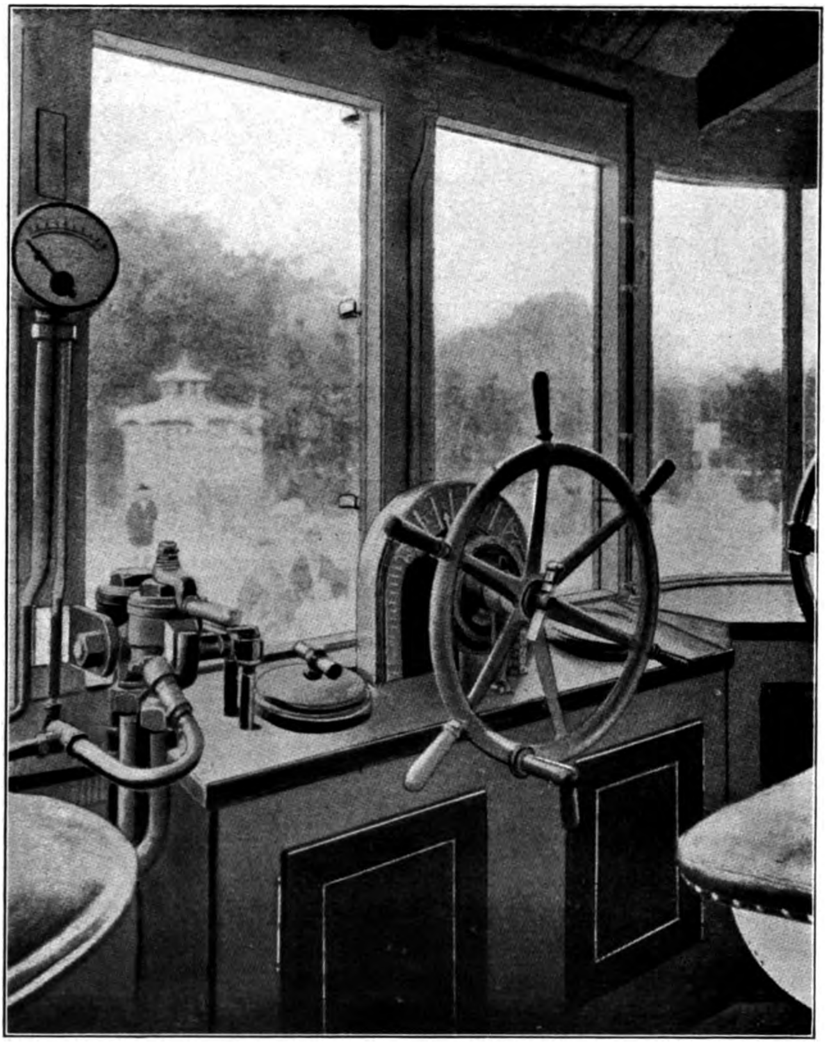
The Motors.—The motors of the A. E. G. car are designed for an output of 250 horse-power each, provided with fork-bar coils; the exciting current has a tension of 435 volts. The motor cases are fixed on an iron frame supported on both sides of the carriage by plate springs, each of which is fixed on the main bearing spring of the car. The motor casings each bear a hollow axle, slipped over the car axle, on which the armature of the motor is built. The motor is coupled to the wheels of the corresponding axle by means of double arms attached on both ends of the hollow axle and touching the sliding pieces placed on the wheels. The weight of the motor, instead of resting immediately on the axles of the car, is thus supported by bearing springs on the axle boxes of the truck.

The motors constructed by the Siemens & Halske Company on the other hand are six-pole motors, also for outputs of 250 horse-power each, the energy current being conveyed to the rotor at a tension of 1,150 volts by means of three sliding rings. The pressure in the secondary circuit at rest and at first starting is 650 volts. The rotor is provided with closed direct-current bar windings, whereas the stationary part of the motor has rotary-current bar windings. The rotor with its box is pressed strongly on the axle of the car. The stationary part of the motor, enclosed by a double cast-iron casing, rests without any intermediate spring on the car-axle bearings. The diameter of the rotor is 780 millimetres, whereas the external diameter of the motor is 1050 millimetres.

Both the direct fixing of the motors on the axles and the suspension by springs on the truck have given full satisfaction in connection with the experiments so far made. In general, the spring suspension seems to be preferable to the rigid suspension of the motor.

Exciters and Resistances.—The exciters and resistances, necessary in starting and in controlling the speed, show also some essential differences in the two carriages. In order to avoid any abrupt variations in the speed and any excessive sparking in the car, the resistances must be switched off from the circuit quite gradually. In the A. E. G. car there are to this effect liquid resistances of the following construction:

The terminal plates of the opened circuits are placed in two reservoirs in the central machine room of the car. Beside each of the reservoirs there is an electrically-driven centrifugal pump, conveying into the upper reservoir a soda solution placed in a box below the carriage. The higher the liquid in the latter, the smaller will be the resistance between the electrodes; the height of the liquid is regulated from the driver's cab by means of a valve. The pumps work permanently during the run, the liquid circulating in a tube conduit ensuring a permanent cooling (refrigeration). This exciter affords the ad-



THE MOTOR-MAN'S STAND IN THE A. E. G. CAR.

vantage of dispensing with the contacts and cable joints necessary in connection with solid exciters.

In the Siemens & Halske car, on the other hand, there are metallic resistances, formed of "Kruppine" bands 45 by 2 millimetres in section. These bands are placed by groups in flat boxes fitted outside on the longitudinal wall of the car below the window. There are in all twenty-nine steps, four being intended for the first inserting and twenty-five for increasing and regulating of the speed of the motors. Below the resistance boxes there are the exciter rollers placed longitudinally and bearing bronze contact pieces; the corresponding contacts are attached to two steel tubes placed one beside the other, and isolated from them. In order to avoid any such disturbances as would attend on an abrupt increase in collecting the current, the single contacts are inserted not simultaneously but successively. The exciting rollers are actuated through a longitudinal spindle traversing the whole of the car, rotated from the driver's stand by means of a conical toothed gearing. In order to facilitate the handling of this controlling device, there is a compressed-air apparatus assisting the driver in starting and reducing automatically the exciter to its zero position if the current has to be switched off. By means of a special gearing, the controlling may be effected also without the aid of compressed air.

The Trials.—In connection with the trials made in the course of the fall of 1901, speeds as high as 150 kilometres, and even in one case 160 kilometres, were obtained. As however rather material oscillations and shocks were experienced even at speeds of 140 kilometres per hour, no further increase of the speed was thought advisable for the moment, the remainder of the year being given up to very valuable measurements and records on the consumption of electric energy. The acceleration obtained after starting was different according to the strain the source of power was put to and the performance of the motors. In order to attain speeds of 100 kilometres, starting distances of 2,000 to 3,200 metres, and starting times ranging between 138 and 220 seconds were necessary, these figures corresponding with a mean acceleration as high as 0.13 to 0.20 metres per second. As however the motors are capable of supplying for short intervals about 3,000 horse-power, whereas for the above acceleration only 700 to 1,000 horse-power are required, this represents by no means an upper limit.

As regards the braking of the cars, both cars may be stopped either by means of Westinghouse rapid brakes, hand brakes, or using back current; the A. E. G. car is in addition fitted with an electric brake. The Westinghouse and electric brakes may be operated from each motor man's stand simultaneously, though the braking equipments are independent for either of the trucks. In the case of an air pressure as high as 6 atmospheres in the braking cylinder, two of which are placed on each truck, the pressure on each of the twenty-four braking shoes arranged on both sides of the wheel is about 6,000 kilogrammes, the braking shoes thus receiving a total pressure as high as 144,000 kilogrammes, 156 per cent. of the weight of the carriage.

In connection with the numerous braking experiments performed, the main point was an accurate observation of the air pressure in the conduits and braking cylinders as well as the ascertaining of the braking time and braking distance. On the basis of the braking curves obtained with these experiments, the braking coefficients may be calculated from the equation

$$fD + W + gMa = p\,(M + R)$$

where f is the friction coefficient

D the total pressure on the braking shoes,

M the mass of the car,

R the rotating mass with regard to the periphery of the wheels,

W the air and proper resistance of the car,

a the gradient of the track,

p the retardation in metres per second.

The following figures are given in the report of the experiments:

for $v = 20$, $p = 1.7$ and $f = 1.7$

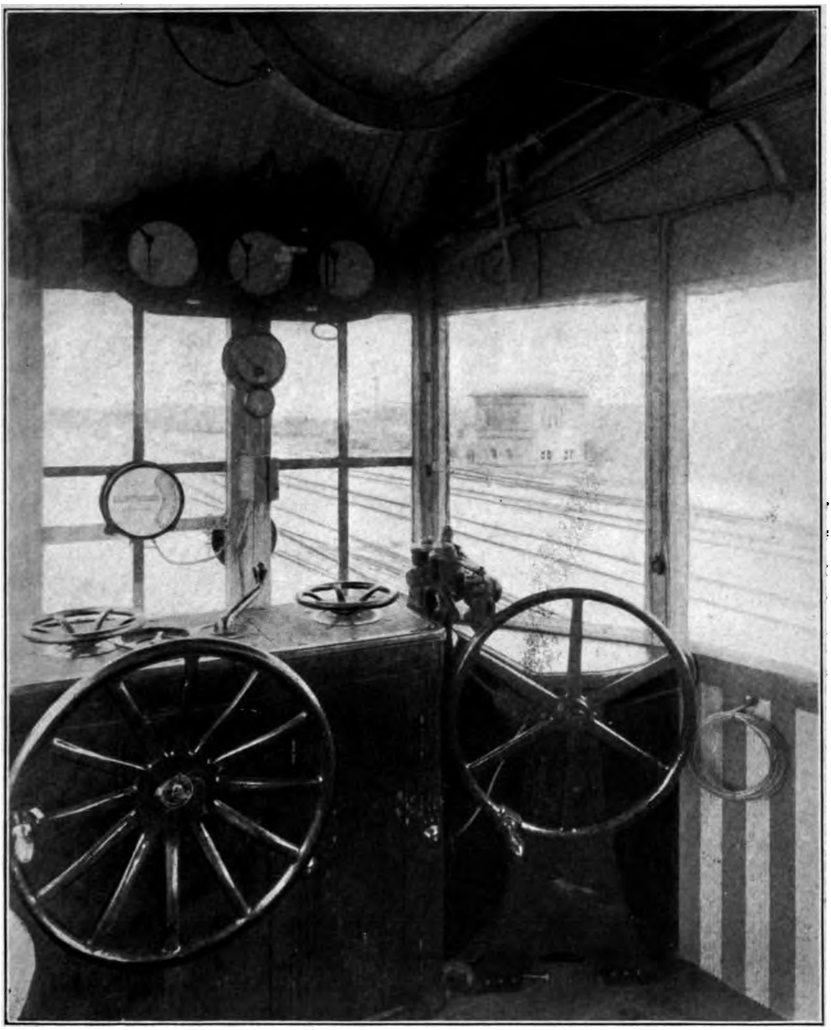
for $v = 60$, $p = 0.75$ and $f = 0.064$

for $v = 100$ $p = 0.6$ and $f = 0.042$

The braking experiments by means of back current as made on the A. E. G. car did not give in the beginning very satisfactory results. As however, back current is likely to act better in the case of higher speeds, the report of the recent experiments will, no doubt, give more satisfactory figures in this respect, though this method of braking is intended to be an emergency braking only.

As regards the resistance of the carriages, the mean value of 3.6 kilogrammes per ton, as obtained for a speed of about 110 kilometres, is materially below the figures calculated from the usual resistance formulae.

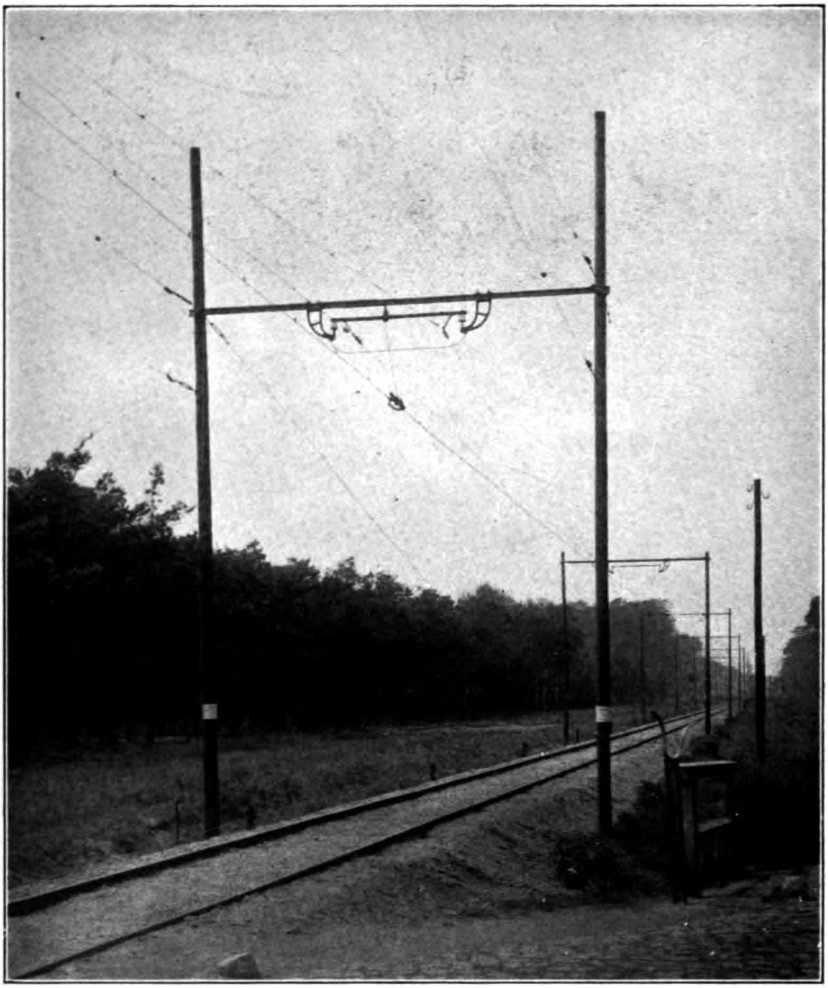
Extensive experiments were made to determine the consumption of energy, both in the electricity works, where records were taken at intervals of 10 seconds, and in the cars, where the tension and current intensities were measured only at intervals of from 15 to 30 seconds. In starting the cars with accelerations ranging between 0.1 and 0.2 metres per second, the consumption of energy in the car on the collectors ranged between 400 kilowatts (544 horse-power) and 740 kilowatts (1,000 horse-power). In the case of prolonged runs, however, the consumption of energy varied between 148 kilowatts corresponding with 90 kilometres, and 520 kilowatts corresponding with a speed of 140 kilometres. It may be stated in this connection that 2,300 kilowatts (2,600 horse-power) have been necessary to obtain the maximum speeds of upwards of 200 kilometres recently attained.



MOTOR-MAN'S STAND IN THE SIEMENS & HALSKE CAR.

When comparing the readings, the great fall in tension will strike the attention in the first place, this fall being due to the fact that the feeding line, 13 kilometres in length, from the electricity works to the military railway, was made up of three copper wires only 50 square millimetres in section.

The air resistance was also carefully studied, recent experiments having given values as high as 210 kilogrammes per square metre for the air pressure.



THE NIEDERSCHÖNWEIDE-SPINDLERSFELDE TRACK AND DOUBLE AERIAL SUSPENSION USED IN THE UNION ELEKTRIZITÄTS GESELLSCHAFT.

The scene of a series of independent experiments.

After the trials made in the course of 1901, a thorough rebuilding of the track, as above stated, was found necessary. This occupied part of the year 1902, the remainder of which was taken up in the continuation of the experiments on the consumption of energy etc. for speeds up to 130 kilometres. The results of the improvements made last year were shown, in connection with the recent trials, to be most satisfactory and even surprising. The track not only stood easily the strain to which it was put by trials at ever increasing speeds, but the cars would now run with such safety and steadiness as to make the shocks of the rails nearly unnoticeable.

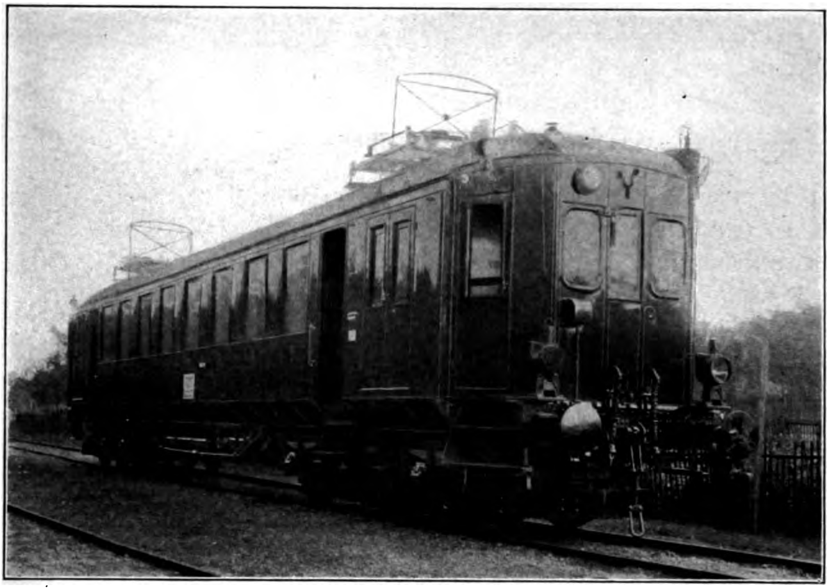
The Siemens' car was first given a chance to show its possibilities; after reaching speeds as high as 189 kilometres per hour at the end of September last, it was anticipated that resuming the experiments at the beginning of October would lead to the maximum speed of 200 kilometres being finally reached. This was actually the case on October 6, the event being watched by a great number of lookers-on. The distance between Marienfelde and Zossen was repeatedly traversed in not more than eight minutes each way, including starting and braking, the maximum speed of 201 kilometres (126 miles) being actually reached on the section Mahlow-Dahlwitz-Rangsdorff traversed in 1½ minutes, throughout about 5 kilometres. The mean speed of 175 kilometres per hour would enable the journey between Berlin and Cologne (577 kilometres) to be completed in about 3¼ hours, whereas the fastest present trains require fully 9 hours.

This result, which aroused such sensation in the engineering world, was exceeded on October 23 when 207 kilometres were reached without any disturbing factors being noted.

The A. E. G. car had meanwhile in turn resumed the experiments, both cars being alternately used in the course of October. In order to ascertain first the working conditions of the car, moderate speeds were used at the beginning, which however could rapidly be increased so that the high-speed car of the A. E. G. on October 28 even slightly exceeded the record made by the Siemens car, reaching the enormous speed of 210 kilometres per hour. Both cars ran so steadily that all those present were highly satisfied.

From a car running at such exceedingly high speeds, neighbouring objects, of course, will disappear from view. Though the motor man would be able to distinguish obstacles on the track, this would be of little use, the braking distance, i. e., the distance from the beginning of braking to the stopping of the train, being 2 kilometres, and 1,600 horse-power having been necessary to obtain the desired speed. Lookers-on could just distinguish the presence of men in the car; before, however, they were able to fix their figure, the car had disappeared from view. Though the track is very straight, there elapsed at most ½ minute between the first appearing of the train and its passage and thence to the instant of its disappearance on the horizon.

As the maximum authorized speed has now been reached, it is not intended, for the moment being, to drive the speeds up to any higher figures, but to complete the measurements already made by an



NORMAL RAILWAY CARRIAGE USED IN TRACTION EXPERIMENTS, NOW BEING MADE BY THE UNION ELEKTRIZITÄTS GESELLSCHAFT.

extensive series of records, so as to ascertain fully the working condition of high-speed electric railways. It is thought probable that under existing conditions speeds as high as 230 to 240 kilometres per hour may be obtained without any difficulty, but as no authorisation is obtained for the moment, this will have to wait for next year. It is thought probable that after the successful results of these trials some railway will be equipped according to the principles ascertained on the military railway, so as to allow of these interesting trials being continued on a larger scale.

In concluding, I wish to give my best thanks to the Manager of the Studiengesellschaft, Regierungsbaumeister Denninghoff, as well as to Dr. Hamburger and Dr. Reichel, chief engineers to the A. E. G. and Siemens Co. respectively, for kindly supplying the data given in this article, and the illustrations here reproduced.

AN EXAMPLE OF THE MODERN DEVELOPMENT OF THE APPRENTICESHIP SYSTEM.

By L. D. Burlingame.

Mr. Burlingame's topic is one of the most important in the practical conduct of modern engineering industries—the provision for the future "rank and file" of the trade. It was treated from a slightly different viewpoint in Mr. Downton's account of the Westinghouse system in our preceding number. We shall follow shortly with some further examples drawn from other progressive and successful shops, and with discussion of the general problem by some of the best informed and most practical thinkers in the world of engineering manufacture.—The Editors.

WE often hear the complaint that the old form of apprenticeship is dead, and that because it is dead the supply of efficient machinists is dying out. By the "old apprenticeship system" is meant that system by which a boy was indentured at about fourteen years of age to a master, who took him into his family to teach him the trade, the apprenticeship lasting until the boy became of age. That such a form of apprenticeship is almost obsolete follows as a matter of course from the changed conditions of manufacture. A trace of the old method still exists, however.

Near my suburban home there is a "village blacksmith" who still takes apprentices in something of the old way. As this blacksmith keeps horses and a small herd of cows, and in addition cultivates a good-sized garden, it can be easily understood what are many of the duties of his apprentice. The boy learns at least what long hours and hard work are. No doubt his experience is nearer to that of many of the old-time apprentices than we are led to think by those who bewail the old system's passing away.

The transition period followed when in small shops, often dirty and cold—shops employing but a few machinists and not more than two or three apprentices—the duties of the "cub" were to open up the shop, light the fires, run errands, sweep the floor, and wipe up and oil the machinery. Interesting accounts of these early experiences have appeared from the pens of such writers as "Chordal," W. S. Rogers, and others. Many of the tedious and routine operations now performed by automatic machinery were then done by hand, and the apprentice boys were the natural victims. That the apprenticeship of those days had *some* advantages cannot be denied; it at least cultivated ingenuity in doing without proper tools and produced a generation of good mechanics.

There is at the present time a general belief that nothing adequate has taken the place of these old systems just described. Such a belief has been so often expressed in educational and mechanical circles that those not informed take it as a matter of course that the apprenticeship system is dead. This belief prevails in spite of the fact that there exists in the United States a well established and growing system of apprenticeship, adapted to modern needs. Investigations have been made from time to time to learn the facts regarding the employment of apprentices. One was made by the editor of the *American Machinist* in 1896, when answers were received from more than one hundred of the leading builders of machine tools, engines, and electrical machinery in the country. While a difference of opinion was expressed, a large majority employed apprentices. In about one-half of these shops they were indentured by a regular written agreement. A similar investigation was made last year by Mr. E. H. Parks, for *Cassier's Magazine,* with like results. A good illustration of the development, in recent years, of a well organized and comprehensive apprenticeship system is shown in that of the Westinghouse Company as described in this magazine last month by Mr. Downton. These are some, among many proofs going to show that we have a live apprenticeship system in existence today among our machinery manufacturers. Often those that are loudest in their cry that the apprenticeship system is dead, and that there are no good workmen, are the very ones who do nothing themselves to remedy the difficulty and keep up the supply.

The Brown & Sharpe System.—At the works of the Brown & Sharpe Manufacturing Company the taking of apprentices has been a part of the established system of conducting the business for a period of time extending over more than half a century. The late Mr. Lucien Sharpe was himself indentured to Joseph R. Brown, who then conducted the business, and served an apprenticeship of nearly five years. Since that time it has been the constant policy of the company to take apprentices and they have proved an important factor in the development of the business. Mr. Sharpe was always strong in his advocacy of such a system. Near the end of his life he expressed the opinion that in the development of his business, nothing could have taken the place of the apprenticeship system, a system under which the boy was indentured for a term of years, by a well defined form of agreement, and an interest taken in him to see that he faithfully fulfilled such an agreement. He pointed out that many of the most important positions in the management of the shop had been filled from the ranks of the apprentices. At the present time over forty such positions within the works are held by those that have served an apprenticeship with the company. A long list of names was recently shown me of some of the past apprentices now holding positions of responsibility in other concerns. The apprenticeship system is not merely a detail, incident to the conducting of this business, but one of the very cornerstones on which its prosperity and permanence rest.

Some Details of the System.—Boys are not accepted as apprentices unless they have an education equivalent to having completed a grammar-school course. It is required that they be physically sound and of good moral character. No boy is employed who is addicted to the use of cigarettes, as it is found that such boys deteriorate as workmen; they are not allowed to use tobacco in the works. A few years ago the term of apprenticeship was lengthened from three to four years, it being considered that more time was needed to train a boy properly as a machinist. It is not expected that even in this time he can become expert, as a specialist, in any branch of the machinist's trade. He can simply lay a general foundation for future development.

The service of apprenticeship is usually commenced between the ages of 16 and 18. The first eight weeks are on trial, after which, if mutually satisfactory, an agreement is entered into for the full term, the pay ranging from 6 cents per hour the first year to 14 cents the fourth year. The boys are given some job work, so rated as to allow them to earn more than their regular wages. This encourages them to put forth their best efforts and aids in bringing their work up to a commercial basis as regards time. A payment of $50 to the company is required from the boy at the beginning of the term of apprenticeship, for the privilege of learning the trade, and as a pledge that he will fulfill his agreement. At the end of the term, in consideration of faithful service, the sum of $150 is paid to the boy.

When a boy begins work a set of tools is loaned to him. If he is accepted at the end of the term of trial, these tools are sold to him and his name stamped on each.

The time in the shop is so divided as to give experience in lathe work, drilling, milling, assembling and erecting, screw cutting, scraping, planing, and on general work. Those making exceptional progress often occupy the positions of sub-foremen before the expiration of their term of apprenticeship. There are now more than one hundred and forty apprentices in the different departments of the works, including twenty-four in the foundry, three in the pattern shop, and eight in the drafting department.

A society has been organized among the apprentices. They hold meetings every two weeks, listening to lectures upon subjects pertaining to the business. The company allows this time from working hours and often furnishes the speakers from among those in their employ who can speak from experience on subjects connected with the trade. The boys are also encouraged to attend evening school, especially to study drafting and mathematics; more than a third of them are now pursuing such studies in a systematic manner. There is a free library for the use of the shop, containing, besides books of general literature, many valuable works on mechanical subjects. A "Handbook for Apprenticed Machinists," written by Oscar J. Beale and published by the company, is put in the hands of every apprentice. It contains valuable information of a practical nature that can be better learned from a book than from other forms of instruction.

It is of great importance that *some one* should have a special interest in the welfare and progress of the apprentices, aside from following up their work from day to day. In the early days of the business this responsibility was assumed by the superintendent of the company. It was not only because he appreciated the value to the company of a loyal and well trained force of young men growing up to fill places of responsibility, but also because of a *personal interest* in the boys that he helped them, both in and out of the shop. Many a man now advanced to a position of trust and responsibility can date his start on the upward path from the kindly, forceful words of counsel or admonition from his superintendent. He still retains his interest in the boys, although the growth of the business has made it necessary to have a man that can devote all of his time to this branch of the work.

A Superintendent of Apprentices.—Some of the foremen felt that if such a position were created, they would be interfered with in the management of their departments and that there would be a conflict of authority. The superintendent urged the adoption of such a plan for some time before these objections were set aside and the plan tried. It has proved so successful that no one would now wish to see it abandoned. This instructor, perhaps better named "superintendent of apprentices," is employed to have general oversight of the boys. He examines those seeking admission, to ascertain their fitness for the work, and explains fully to them and to their parents or guardians the requirements, so that there may be no misunderstanding. It is important that only such boys be indentured as show an interest in their work and an ambition to learn the trade. Boys brought by their parents who wish them to serve an apprenticeship because they will not attend school are, in most cases, poor material with which to work. Care in selection at the beginning goes far towards insuring success.

The man in charge of the apprentice acts as instructor in some of the rudiments of the trade, in the care of machinery, the proper form and use of tools, and in the best ways of doing the various kinds of work. This is not to relieve the foreman of any responsibility in regard to the boys, but as an additional help to both. Although the main work of instruction comes under the foreman and sub-foremen in the department where the boy is working, there are other points needing attention that come outside their regular duties. These can be better cared for by one man having an oversight of all the boys. He can keep an eye on their habits, especially those of boys living away from home, and see that they have proper care in case of sickness. He can often help them over hard places both in and out of the shop, and can guide them on the road to greater usefulness to themselves and their employers. He can encourage them to be neat, careful, and quick in their work, to study such subjects as will help them to advance, and so to apply themselves as eventually to become masters of their trade; he can see that they have justice and a uniformity of treatment. Even in small shops, where the whole time of one man would not be required for such work, it should be the duty of some one to give what time is needed to it.

It should not be expected that the system successful in one department will suit the needs of all others, to say nothing of one shop working exactly along the lines of another. This stretching out one, and chopping off for another, as if to fit the fabled "Procrust Bed" results only in mutilation. Each must study his own needs adapt a system to his special conditions.

Apprentices in Drafting.—In the drafting room there is a form apprenticeship adapted to the special needs of that department. H the time of service is two and one-half years, six months of which spent in the machine shop. The apprentice first enters the draft room and, after working there for five months, is transferred to shop where he is instructed in the work of the different departme It is not expected to turn out machinists in this short time. The int tion is to familiarize these boys somewhat with shop methods, with use of tools, and with the operation of machines, so that they n have a better appreciation of the work they will be called on to do wl they return to the drafting department; also that they may avoid so of the mistakes characteristic of draftsmen without shop traini mistakes showing inexperience and lack of practical knowledge, n takes that hold some draftsmen up to ridicule among the men in shop.

Boys, before being accepted as apprentices in the drafting depa ment, must have had sufficient technical or other preliminary trai already to have mastered the rudiments of drafting. When the boy served a full apprenticeship in the machine shop before entering drafting room, the time is shortened and he is not required to se further in the shop. The usual age for entering the drafting depa ment is from 19 to 22 years, and the pay from 10 cents per hour at start to 17 cents during the latter part of the time. The sum of $5 paid at the close of the apprenticeship, if merited, as a reward faithful service.

Core-Makers' Apprentices.—Another recent development of system to meet new conditions is the taking of apprentices into core-making department of the foundry. It was found that experien workmen for this department were not available. To insure a sup it was decided to take apprentices to learn the core-maker's trade i thorough manner. The ordinary form of apprenticeship did not se suited to such work. It was thought desirable to have apprentices st at a more advanced age, from 18 to 22 years, so the time of service made 3 years only. As this trade does not give as great an opportu for future advancement, not holding out as great inducements to en it, the wages were made higher than for the regular apprentices as machinist, commencing at 12 cents per hour and reaching 18 ce

The payment of $40 required at the commencement for the privilege of learning the trade can be made in weekly installments of one dollar each, if desired. A bonus of $140 is paid at the end for faithful service.

The apprentices in the pattern shop are given an experience of several months in the foundry and core room during the second year of their service.

American Boys as Apprentices.—The assertion has repeatedly been made that American boys will not serve an apprenticeship, and that American shops are being filled with foreign workmen. The experience of this company does not seem to bear out such a statement. A large percentage of the boys are American-born.

Some years ago a letter was published in the *American Machinist,* asking for a boy to serve an apprenticeship in a small shop in Ohio. About a year later the proprietor wrote:—

> "We were overwhelmed with letters, most of them very intelligent too, from Maine to British Columbia, North and South. We made a selection and one we are well pleased with. If employers would give more attention to procuring worthy apprentices, and after trial reject those not well qualified, the shops would soon be filled with better workmen."

If it be true that there is a feeling among American boys that all the prizes of life are to be found in the professional and mercantile callings, and that boys of ability are turning in these directions, it makes the opportunity all the greater along mechanical lines for those that would seek the best openings for advancement. That the future is large in possibilities along these lines scarcely need be stated.

The School Shop as a Substitute.—For many years, Prof. John E. Sweet has recommended the "school shop" as a substitute for the apprenticeship system, regarding it as the best way to keep up the supply of skilled mechanics, and in a recent paper read before the Metal Trades' Association of Syracuse, he again sets forth his reasons for such a plan; the alternative he sees is for the boy to pay a tuition for the privilege of learning his trade in the machine shop, as he would if pursuing a college course. Prof. Milton P. Higgins also advocates the school shop. He presented a paper before the convention of the National Educational Association held in Boston last summer, explaining the needs and working of such a plan. The arguments advanced in favor of such schools are based, largely, on the supposition that the apprenticeship system is dead, giving no opportunity for a boy to learn the machinists' trade, because manufacturers cannot afford to be troubled with apprentices—that the investment per machine is now so high that it is not economical to put such machines in the hands of learners—that work is so specialized that, if apprentices are employed, they will be kept on one operation or on one machine and will not learn the trade properly.

That some of these arguments have weight, and must be considered, cannot be denied. That cases exist where it is not practical or economical to take apprentices is, no doubt, true. It is evident that there is a field for the extension of school training made more practical and as near as possible to real work.

There is much that is hopeful in the modern development of our school system and in these proposed plans for its further extension along practical lines, but it does not seem that such plans can give the equivalent in training of a service of apprenticeship such as has just been described, especially in cases where the apprentice adds to his experience in the shop the school knowledge he gets by evening study.

The boy coming from the school shop, no matter how good his training, must start as an unknown quantity with his new employer and win his way from the beginning. The boy already four years in the service of an employer as apprentice may have won his confidence and esteem; he may have developed such ability and shown such a spirit of loyalty as to have put him in the line of promotion even before he completes his apprenticeship. There is no better way to maintain the vitality and keep up the standard of a shop than by training young men in the shop itself, preparing them to assume the responsibilities later on. If not profitable otherwise, it is worth more than all it costs for this alone. That *it is often profitable* is shown by the following opinion of a shop foreman—it is but one among many; he says:—

> "These bright, active apprentice boys are really of more value in a shop than many of the regular journeymen. They are ambitious to learn and to excel and, when properly encouraged, will get out as much work as some men who have been at the trade a dozen years."

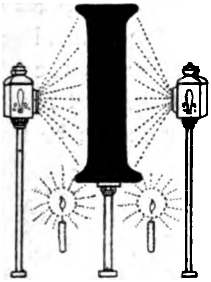
It may be that in time the standard for admission to shop apprenticeship can be so raised as to require a special school training, fitting the boy for entrance to the shop, in a way similar to that now required for entrance to the drafting room just described. There is a suggestion of this in the fact that graduates of the Providence Manual Training High School, coming well recommended by the principal, may have the term of apprenticeship in the machine shop shortened. With an extension of such schools as recommended by Professors Sweet and Higgins, still further steps in this direction might be taken, steps to ***strengthen,*** rather than to ***supplant,*** the apprenticeship system.

The influence of the schools is shown in many of the modern forms of apprenticeship. In such systems as exist at the Westinghouse Company, the apprentices are divided into classes according to education. Such a system seems well adapted to the needs of large works requiring, besides workmen, a number of technically educated experts. The Baldwin Locomotive Works find the system suited to their needs to be one having three classes of apprentices and combining a course of evening study as a required part of the training. In many lines of mechanical work, such an elaboration of the system would not, of course, be required, especially among the smaller shops. It does seem, however, that there should be a more definite agreement than now exists in many places nominally taking apprentices; that this should be in the form of a written agreement, as to time of service and wages, with a money forfeiture in case of failure on the part of the apprentice to fulfill his agreement, and with a reward at the end for faithful service; and that there should be a personal interest taken in the boy throughout his apprenticeship. It is my opinion that the best results in the development of the modern apprenticeship system can be thus attained.

THE HOMES OF THE GREAT ENGINEERING SOCIETIES.

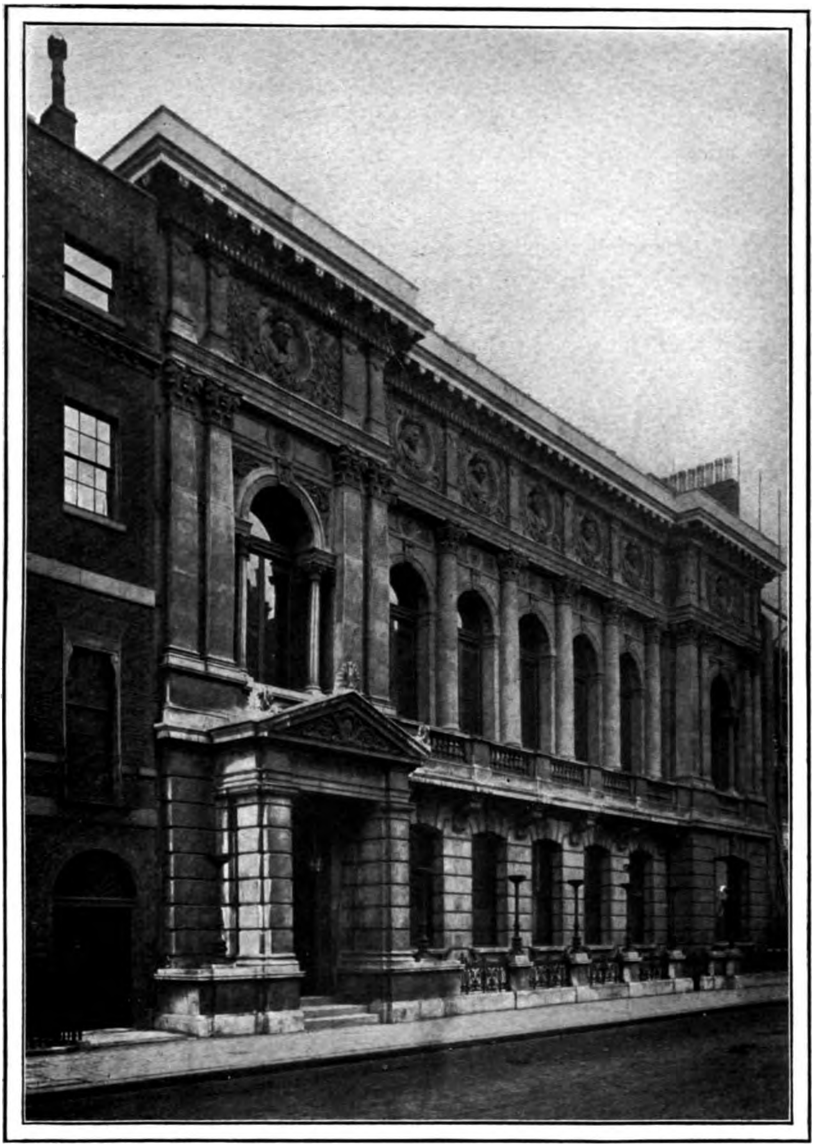
By Henry Harrison Suplee.

At the present time the value of association for the development of engineering work is fully understood, and in nearly all civilized countries organizations exist, devoted to the work of different branches of the profession. Some of these have attained a sufficient measure of success to be able to possess homes in which to hold their meetings and to house their libraries and other belongings, and from among these we have selected some of the most noteworthy in the belief that the features which have commended themselves to experience may be of interest and value to those who are considering the construction of a society home and headquarters.—The Editors.



IT was not until early in the nineteenth century that the engineer, the man who above all others was destined to change the face of the civilized earth, really attained such a professional position as to feel himself qualified to form an association for the exchange of opinions and the furtherance of his work, and it was in England, the home of some of the greatest engineering developments, that the first of the national engineering societies, the Institution of Civil Engineers, was founded, the date of its foundation being January 2, 1818.

According to an interesting historical account of the Institution, published in the Proceedings of the Institution for 1886, and presumably from the pen of the Honorary Secretary, Mr. James Forrest, the first formal meeting was held in the Kendal Coffee House, in Fleet Street, and the persons who took the initiative in forming the society were six young men, then beginning their engineering life; William Maudslay, Joshua Field, Henry Robinson Palmer, James Jones, Charles Collinge, and James Ashwell. For two years these, and others who joined them, continued to meet, and the success which they gained by the interchange of experience encouraged them to endeavor to extend their work by a bold stroke. This was to offer the presidency of the Institution to the foremost civil engineer of the time, Thomas Telford, and thus at one leap to attain a prominence hitherto lacking. The following resolution, passed on January 23rd, 1820, is the record of this action:



THE INSTITUTION OF CIVIL ENGINEERS.

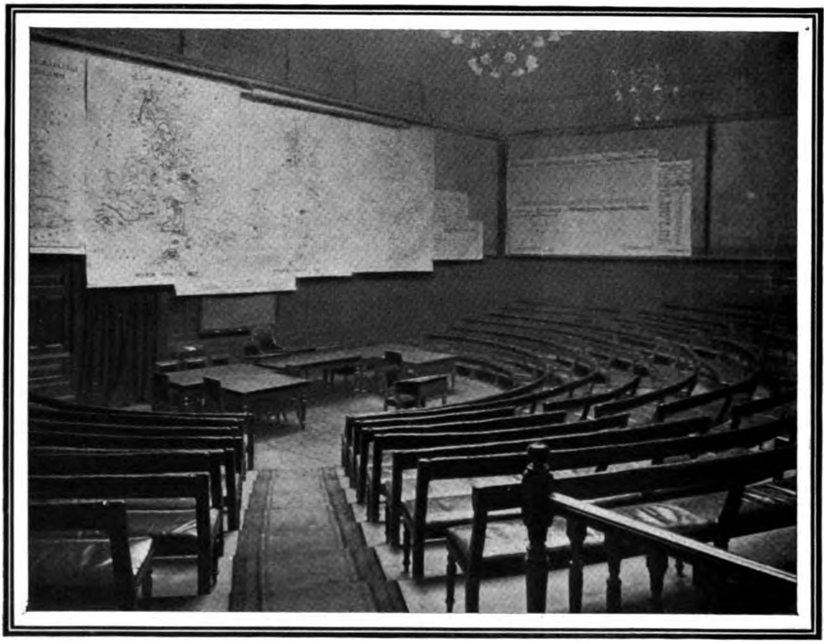
Great George Street, Westminster, on the prolongation of which a short distance beyond is the building of the Institution of Mechanical Engineers. The portrait busts on the upper portion of the façade are those of eminent British engineers.

"That in order to give effect to the principle of the Institution and to render its advantages more general, both to the members and the country at large, it is expedient to extend its provisions by the election of a President whose extensive practice as a civil engineer has gained him a first-rate celebrity, and that a respectful communication be made to Thomas Telford, Esq., Civil Engineer, requesting him to patronize this Institution by taking upon himself the office of President."

Although Telford had never heard of the society before, he accepted the nomination, and was duly installed, and under his care and reputation the Institution developed to such a degree that in 1828 it received a Royal charter of incorporation. Telford continued to evince a deep interest in the work of the Institution until his death in 1834.

According to the original "Regulations" the Institution was declared to have been formed "for facilitating the acquirement of professional knowledge, and for promoting mechanical philosophy." In the charter of 1828, however, the Institution is stated to have been established:

"For the general advancement of mechanical science, and more particularly for promoting the acquisition of that species of knowledge



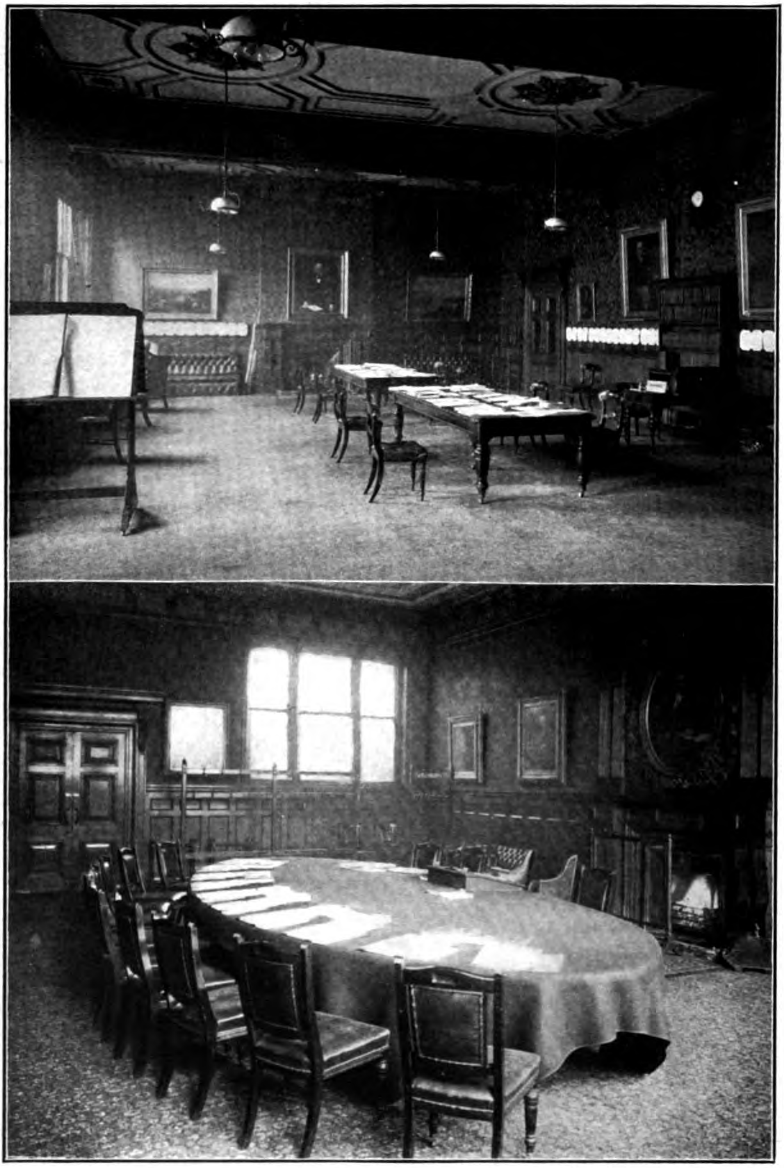
THE MEETING ROOM, IN THE INSTITUTION OF CIVIL ENGINEERS.

THE MAIN STAIRCASE, INSTITUTION OF CIVIL ENGINEERS.

The scene of many brilliant and distinguished gatherings at the receptions of the Institution.

which constitutes the profession of a Civil Engineer; being the art of directing the great sources of power in Nature for the use and convenience of man, as the means of production and of traffic in States, both for external and internal trade, as applied in the construction of roads, bridges, aqueducts, canals, river-navigation and docks, for internal intercourse and exchange; and in the construction of ports, harbours, moles, breakwaters, and lighthouses, and in the art of navigation by artificial power for the purposes of commerce; and in the construction and adaptation of machinery; and in the drainage of cities and towns."

This exhaustive definition of the work of the civil engineer is believed to be from the pen of Tredgold, and it has been more or less accurately quoted many times since. When it is considered that it was written in the year before the Rocket made its triumphant run at Rainhill, when steam navigation was at its beginnings, when the science of applied electricity was undreamed of—in short, in the infancy of engineering as it is now understood—the scope which it gave to the profession is remarkable. That is has since been sought to limit the work of the civil engineer to a smaller portion of this field is a matter



THE INSTITUTION OF CIVIL ENGINEERS.

The upper picture shows the periodical reading room, and the lower the council chamber, over the table of which hangs the portrait of Telford.

for regret, but there is now every evidence that the various branches of the profession in English-speaking countries are destined to join in their work and their associations to an extent fully as great as exists to-day in France or in Germany. Broadly, the term "civil engineer" was originally intended to differentiate the engineer in civil practice from the engineer in military service; the one "directing the great sources of power in Nature for the use and convenience of man," and the other exerting himself to divert the same great sources of power to the misuse and inconvenience of man.

The Institution of Civil Engineers at first occupied rented rooms at 15, Buckingham St., Adelphi, but in 1834 the members aspired to own a home of their own, and a small house at No. 1, Cannon Row, Westminster, was taken. These quarters gradually became inadequate, and on Christmas, 1838, the site of the present handsome house was first occupied, the house at 25, Great George St., Westminster, being taken, and a meeting room about 30 feet square being built in the rear of the front house. In 1865 the question of a new house was agitated, and in 1868 the adjoining property, No. 24, was secured and the house enlarged and practically rebuilt.

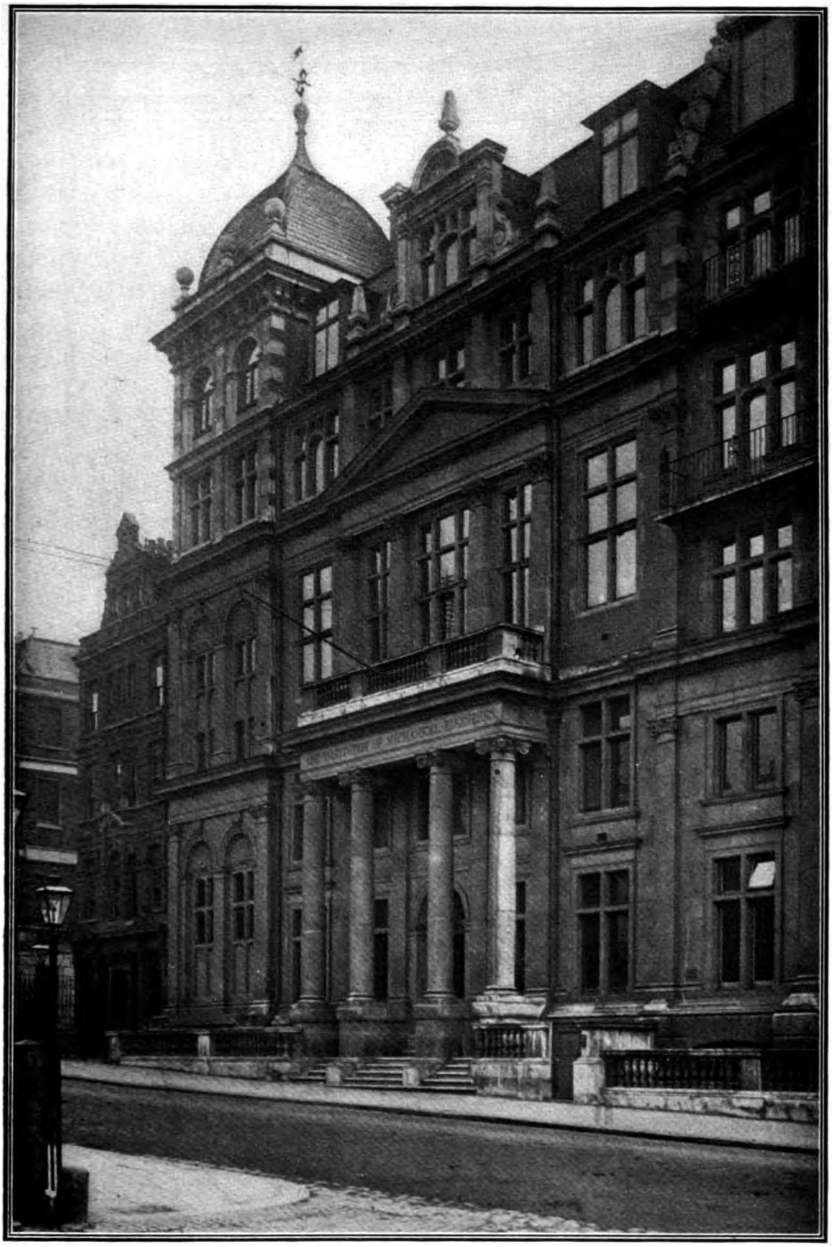
The present fine building stands upon the same site as its predecessors, a third house having been acquired, and an entirely new structure erected in 1894-1896 from designs by the late Mr. Charles Barry. The cost of the building was about £50,000, and the site is valued at about as much again, so that the present value of the premises may be taken as about £100,000. This building contains a fine theatre or general meeting hall, ample room for the library, together with offices, council room, store rooms, and quarters for the housekeeper. The Institution is fortunate in the possession of a great number of fine portraits of eminent engineers and members, and these hang on the walls of the meeting rooms and the other rooms, while at the head of the great staircase is a marble tablet upon which is inscribed the list of names of the successive presidents of the Institution, this forming practically a roll of honor of the most eminent names in the profession.

In addition to the names of the presidents, it is well understood that the secretary is the man to whom falls the laboring oar in the propulsion of the work, and the Institution of Civil Engineers can regard with equal pride its list of presidents and secretaries. The first of the secretaries since the Institution occupied an important position was Mr. Thomas Webster, Q. C., the father of the present Chief Justice, Lord Alverstone. His successor was Mr. Charles Manby, whose work and acquaintance with engineers at home and abroad did much to further the progress of the Institution. Mr. Manby was succeeded in 1856 by Mr. James Forrest, beloved alike in Great Britain and in the United States for his kindly personality and for his enthusiastic work for the advancement of the engineerng profession. Mr. Forrest continued in active service until 1896, when he was made honorary secretary, being followed by Dr. J. H. T. Tudsbery, the present incumbent, most efficient and helpful to all who come in contact with him in the administration of his work.

THE LIBRARY OF THE INSTITUTION OF CIVIL ENGINEERS.

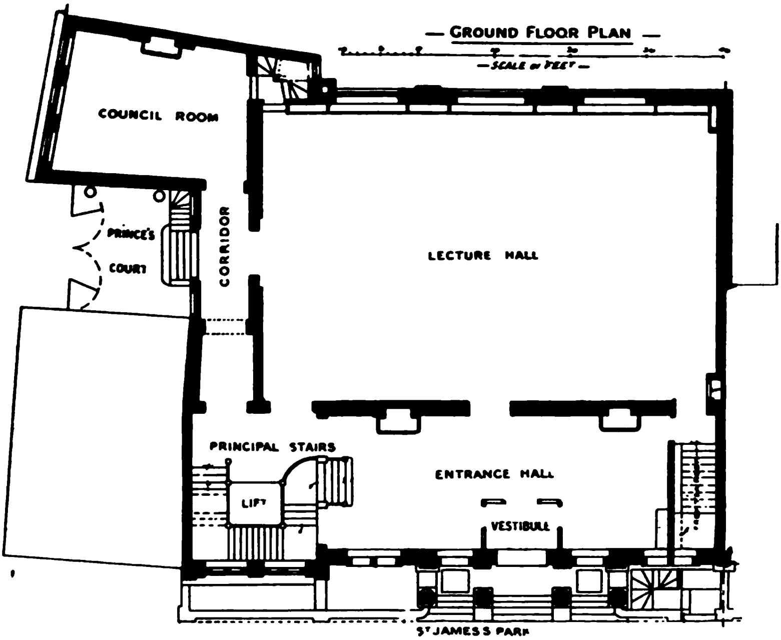
The library of the Institution, having its origin in the bequest of his books by Telford, is now estimated to contain 55,000 volumes and 15,000 pamphlets, and practically every standard work on engineering in the English language is to be found there, as well as many in other languages. Being constantly augmented by the presentation of copies of the works of the members as well as by purchase, it is doubtless the most complete general engineering library in existence at the present day.

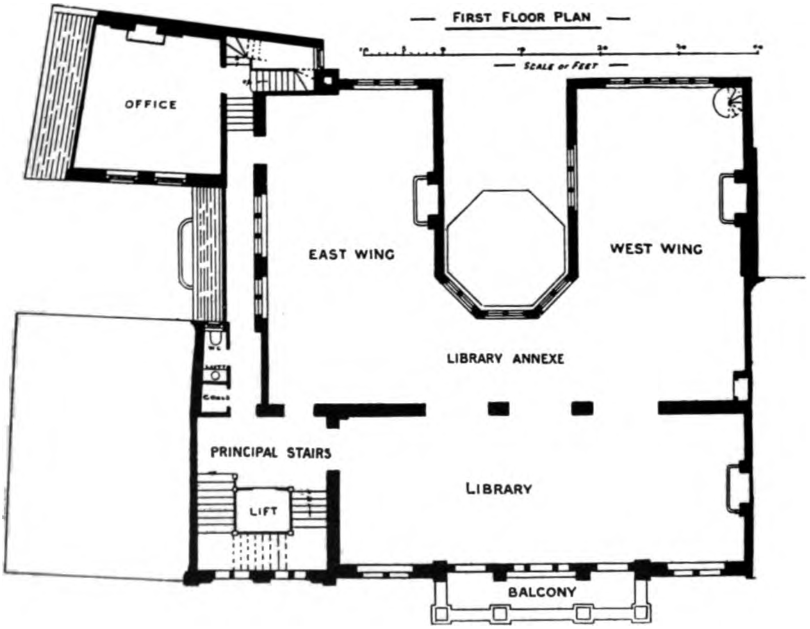
The Institution of Mechanical Engineers, the sister society and near neighbor of the Institution of Civil Engineers, had its origin not in London, but in Birmingham; the first general meeting there being the result either of a gathering of engineers at the house of Mr. Beyer



THE INSTITUTION OF MECHANICAL ENGINEERS.

Storey's Gate is seen (in part) just beyond the corner of the adjoining building on the right. Birdcage Walk, passing in front of the Institution, leads through the gate into Great George Street, a short distance down which, on the left, is the Institution of Civil Engineers.





INSTITUTION OF MECHANICAL ENGINEERS.

The arrangement of the bay in the library provides for overhead lighting of the hall below and also light and air for the library wings. Note the convenient communication of the council chamber with the hall and with the office of the secretary.

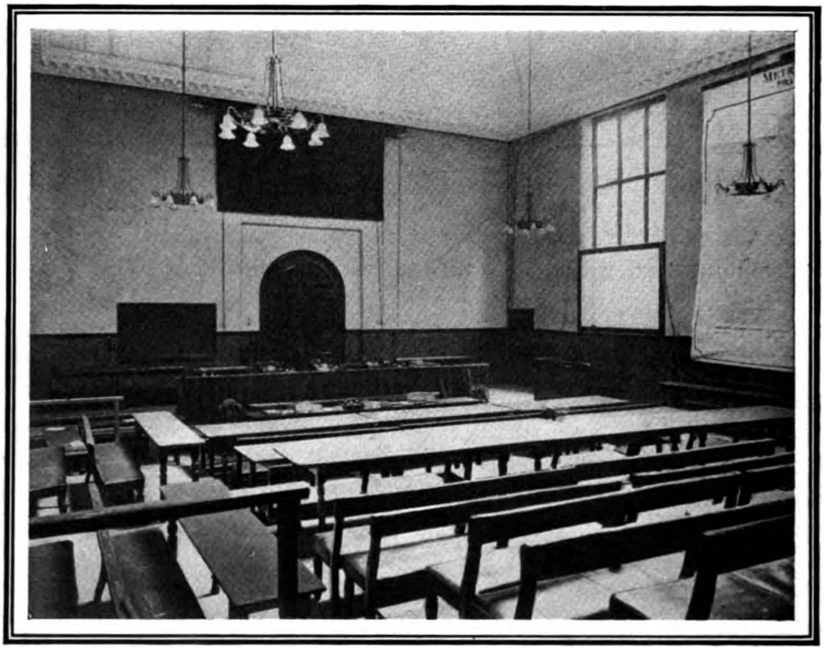
in Manchester, or at the residence of Mr. McConnell, near Bromsgrove. The organization meeting was held at the Queen's Hotel in Birmingham, on January 27th, 1847, and at this meeting Mr. George Stephenson was elected by acclamation the first president. For several years the society continued to meet in Birmingham, the membership reaching about two hundred, when, in 1856, through the efforts of Mr. James Fenton, a member of the Council, the plan was adopted of holding summer meetings at various engineering centres, the first of these meetings being held at Glasgow under the presidency of Mr. Joseph Whitworth. The effect of these meetings was a rapidly increasing interest and activity among the members, the membership growing steadily, until, in 1877, when the society removed from Birmingham to London, there were more than a thousand members.

No attempt was made at first to secure a house for the Institution, rooms for the business staff and the library being obtained at 19, Victoria St., Westminster, and the London meetings being held in the hall of the Institution of Civil Engineers by the courtesy of that society, an evidence of the good will and hearty co-operation which has always existed between the older and younger organizations.

An important department of the work of the Institution of Mechanical Engineers has been conducted by its various research committees, these investigations including experimental studies of the strength of riveted joints, the hardening and tempering of steel, friction at high velocities, marine-engine trials, steam jackets, gas engines, and the properties of alloys. Since 1879 upwards of £4,000 has been spent in these researches, the expenditures in all cases being limited to the working costs, the numerous and eminent members who have served on these committees giving their services gratuitously.

Since 1899 the Institution has occupied its present handsome building, situated at Storey's Gate, St. James' Park, Westminster, being on the prolongation of Great George St., which, after passing Storey's Gate, is called the Birdcage Walk. The building is thus within a stone's throw of the house of the Institution of Civil Engineers, and yet possesses the advantage of a front overlooking a Royal Park, with a magnificent view over the Horse Guards Parade. It is in close proximity to important government offices, including the Foreign Office, the Office of Works, and the new Admiralty Buildings.

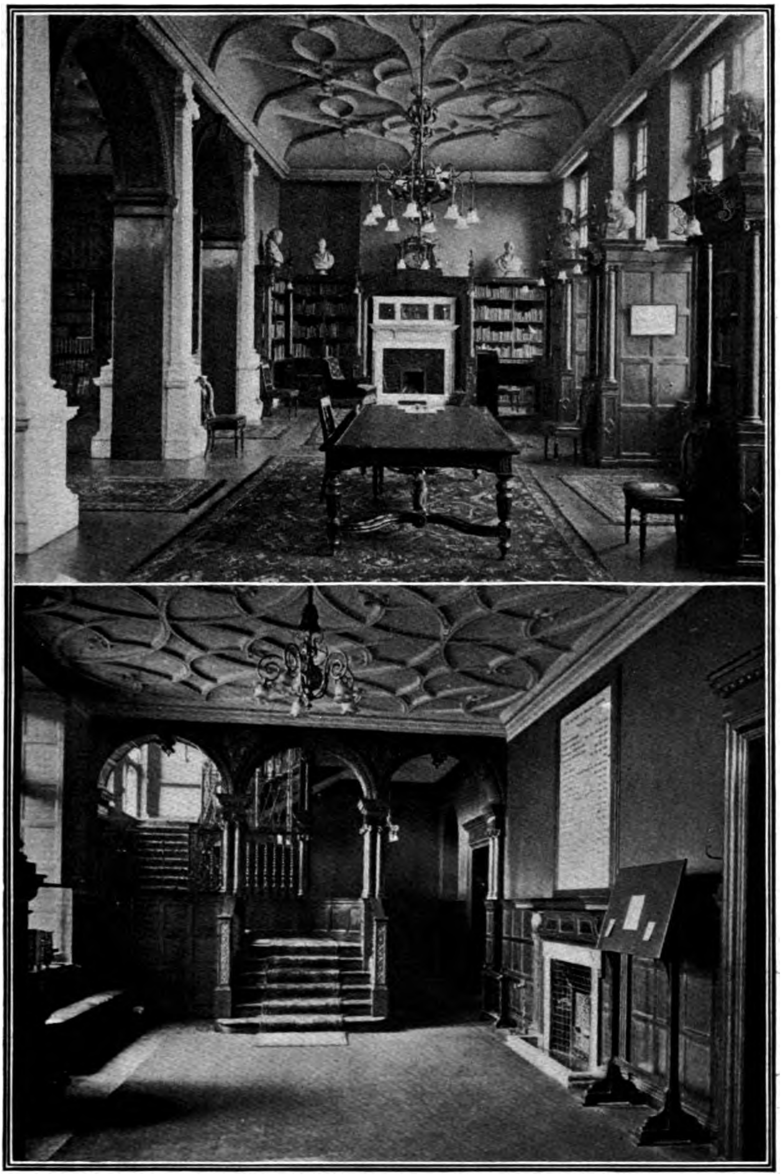
The general appearance of the house is well seen from the illustrations, while the arrangements are well adapted for its purposes. The main hall is ingeniously provided with a floor built up of movable platforms or boxes, which, when uniformly distributed, provide a level floor, flush with the vestibule without, while by suitable arrangement they may be built up into a series of terraces for conversion of the room into an auditorium for meetings. By this simple contrivance a single large room is made available at short notice either as a theatre or as a reception room. The Institution at present possesses a library of about 10,000 volumes, most conveniently arranged in alcoves on the first floor, these rooms being very handsomely finished in Hungarian oak. An electric lift is placed in the middle of the shaft for the main stairway, both lift and stairway being fitted with artistically forged iron-work grilling.



THE MEETING HALL, IN THE INSTITUTION OF MECHANICAL ENGINEERS.

The door at the rear of the stage leads through a corridor to the council room. At the window on the right is seen one of the ground-glass screens behind which the ventilating and warming current is admitted.

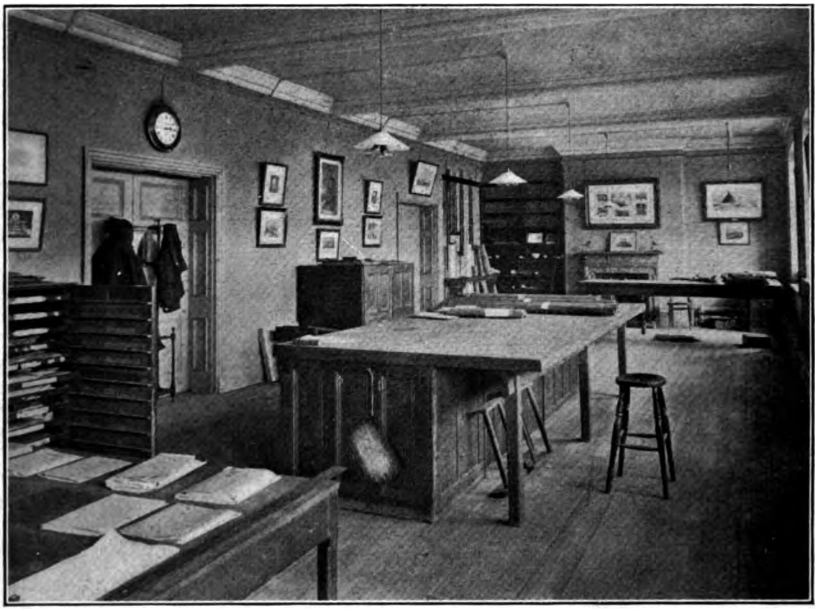
An interesting feature of the building is the system of ventilation, the fresh air being drawn in from the park by an electrically-driven fan, and after passing through fibre screens over which a sheet of water is kept flowing, it is passed over radiators and delivered into the main hall through passages formed between the windows and glass screens placed in front. In this way all draughts are avoided, while the air is at the same time delivered at points where its warmth can



THE INSTITUTION OF MECHANICAL ENGINEERS.

Below is seen the entrance hall, the tablet on the right bearing the names of the presidents of the Institution. Above is a part of the library.

counteract the chilling effects of the windows. An important portion of the building is found on the upper floor, where there is provided a drawing room especially adapted for the rapid production of large wall diagrams and drawings in connection with the presentation of papers, and there is also a meeting room for the "graduate" members of the Institution. This plan of providing for the junior members a room which they may feel belongs especially to them for their own gatherings, appears to be a most desirable feature, worthy of imitation elsewhere.



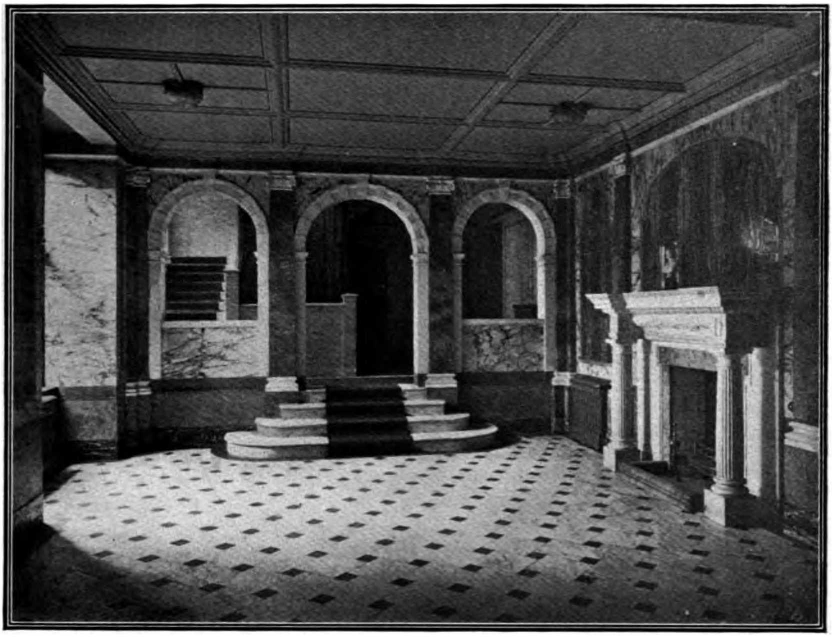
THE DRAWING OFFICE, INSTITUTION OF MECHANICAL ENGINEERS.

The secretary's office is especially commodious and convenient, while beneath it, and in close proximity to the principal meeting room, is the council chamber, both this room and the office of the secretary being given private communication with the main hall.

One of the most beautiful portions of the house is found in the so-called "tea room" in the entresol, this running under the full length of the entrance hall. This room is lined throughout with costly marbles, new and rare stones having been selected in order to produce the most striking effects. The general style of the room is Italian; the pilasters are of antique sienna with statuary white caps and bases, while the surbase is of dark dove, with dado of cippolino and verte antique plinth. The panels are of picked Mexican onyx, showing beautiful veining, and the whole effect of the room is most artistic. Here the refreshments are served during the conversazioni held during the season, there being a convenient kitchen and pantry adjoining.

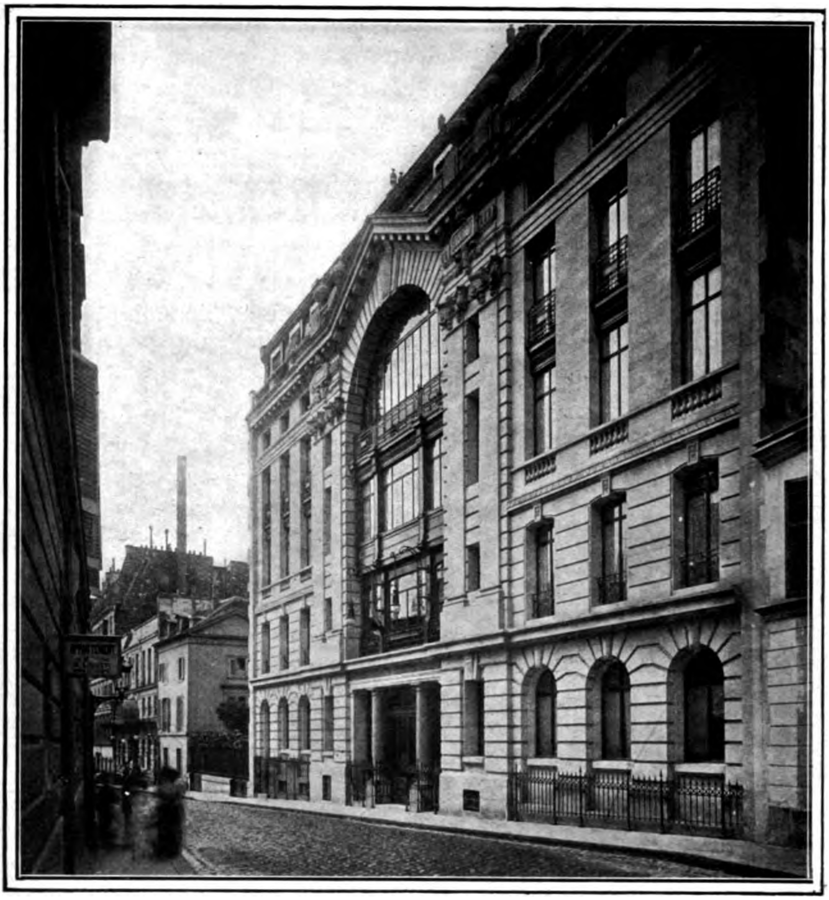
In the basement there has been made ample storage provision for "proceedings" and other papers, together with a fine lavatory, and arrangements for large coat rooms, these features often being given insufficient consideration in the design of such buildings.

The result of experience with this building since its occupation by the Institution shows it to be excellently adapted for its purposes, and there are numerous details in its construction which might well be considered in the planning of structures for similar uses elsewhere. Mr. Edgar Worthington, the present secretary, with his assistants, has succeeded in organizing the operative administration of the Institution in a highly efficient manner, and among the great engineering societies of the world the Institution holds a prominent position.



THE TEA ROOM OF THE INSTITUTION OF MECHANICAL ENGINEERS.

Passing to the Continent, we find that the differentiation between the various branches of the work of the engineer, however far it may have been carried in practice, has not extended to the professional societies to the same extent as obtains either in England or in the United States. The Société des Ingénieurs Civils de France un-



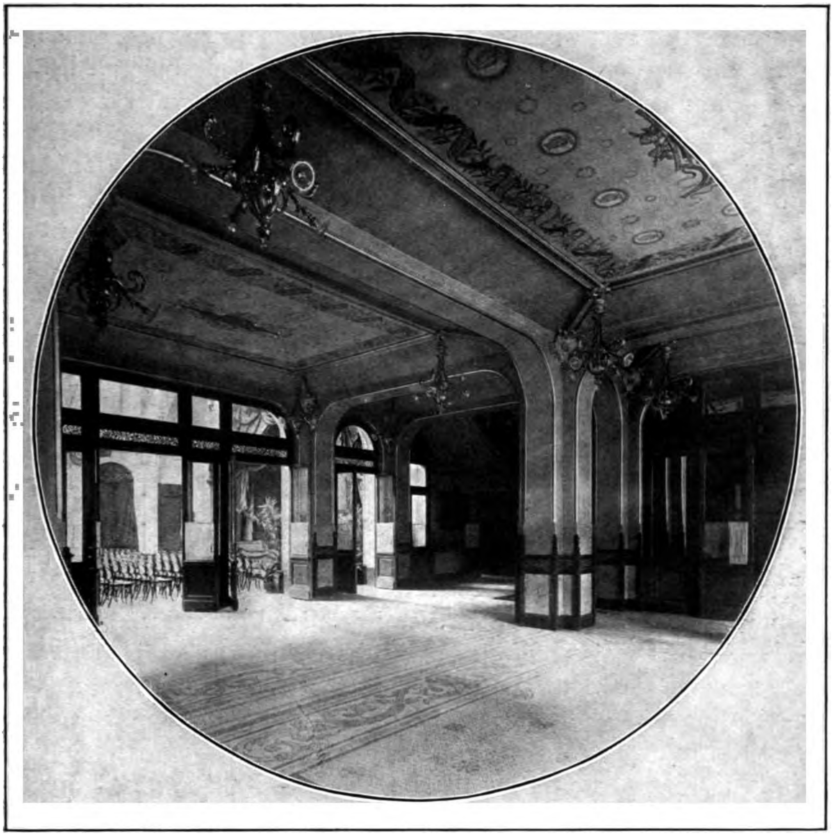
SOCIÉTÉ DES INGÉNIEURS CIVILS DE FRANCE.

Façade of the building on the Rue Blanche. This street leads directly to the Rue de la Chaussée d'Antin and to the Boulevards and the heart of Paris.

doubtedly represents the whole of the profession in its country; while the Verein Deutscher Ingenieure is not only the national engineering society of Germany, but by its system of organizing local branches, or "Bezirksvereine" it has carried the influence of professional engineering associations to a wider scope than exists in any other country. Both of these societies possess handsome modern houses, and it is believed that some account of these establishments in Paris and in Berlin may well follow those of the homes of the British societies.

The Société des Ingénieurs Civils de France, like many other liberal institutions on the Continent, had its origin in the stormy year

1848, when the newly recovered freedom of thought and action vented itself in the establishment of bodies which have since had a profound influence upon national life and activity. It was on March 4, within a month after the revolution of February 1848, that a group of former pupils of the Ecole Centrale met and formed the society of civil engineers which since that date has grown to be the representative organization of all branches of the work of the engineer in France.



SOCIÉTÉ DES INGÉNIEURS CIVILS DE FRANCE.

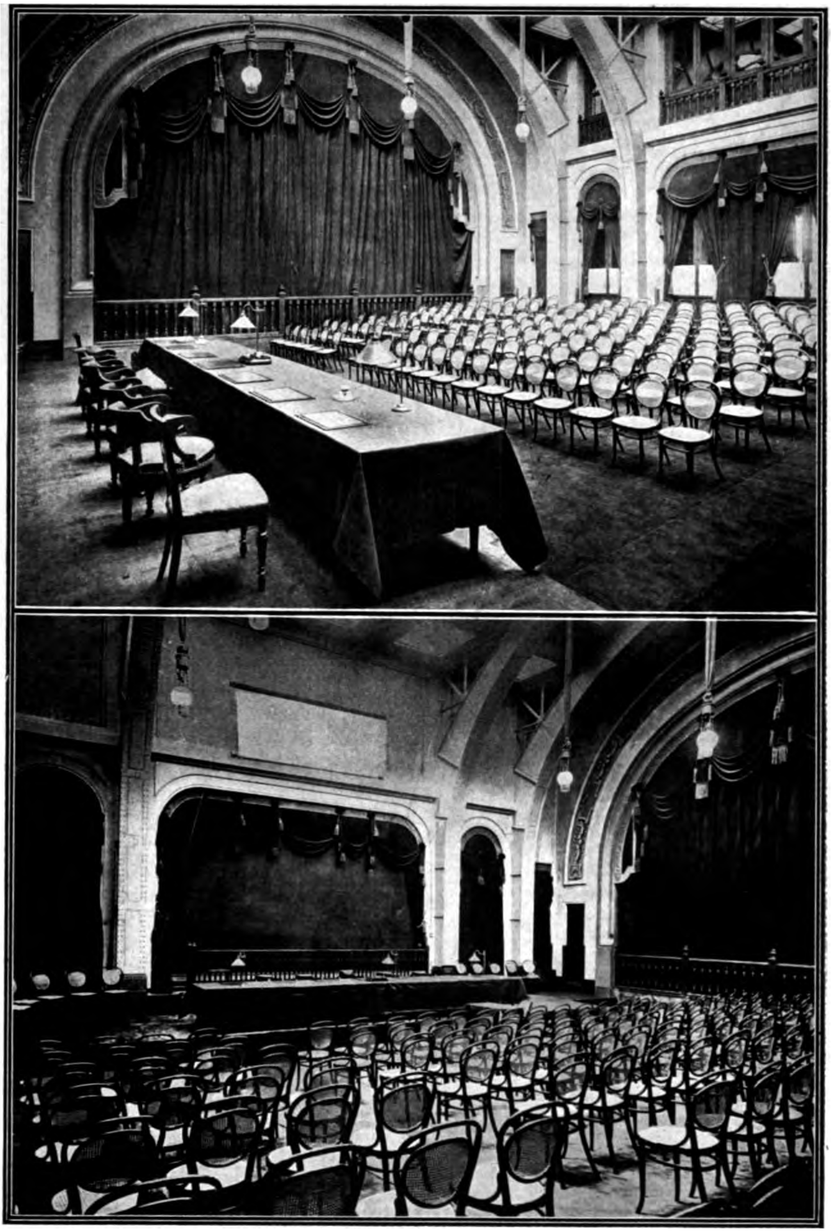
View from outer lobby, showing the relation of the main hall and inner lobby to the entrance; the visitor is just entering from the street.

The early meetings of the society were at various places; at the rooms of the Société d'Encouragement, then in the Rue du Bac, in the Rue Duphot, the Rue des Bons Enfants, and at the Imprimerie Chaix, in the Rue Bergère. The papers and archives of the society were in charge of M. Husquin de Rhéville, who continued to act as secretary-archivist until his death in 1887, while the first president was M. Eugene Flachat, who held this office seven different times, the last being in 1867, and was honorary president from 1868 until his death in 1873. The original founders of the society in 1848 numbered one hundred and thirty-five, and according to the catalogue of 1903 but twelve of these are now living.

After remaining in the quarters in the Rue Bergère for 18 months the society sought larger accommodations, and rented a house at No. 26, Rue de Buffault, where for twenty-two years it remained, although during the latter portion of this time, when the membership numbered nearly one thousand, the rooms were often uncomfortably crowded. In 1868, following closely upon the impetus given to the work of the society by the exposition of 1867, a site was obtained in the Cité Rougement, just off the Boulevard Poissonnière, and a new building was planned and partly completed when the events of 1870-1871 caused work to be suspended. The new building was finally opened in the summer of 1872, and remained the home of the society until 1897, when the present handsome building in the Rue Blanche was opened with appropriate ceremonies. The construction of a new building was decided in 1895, and its erection was accelerated by the opportunity for the sale of the existing property, with the requirement for early delivery. As a matter of fact the building was finished in 262 days from the time that the site was cleared, being opened for use on January 14, 1897; the old house having been given up on the 15th of December preceding.

The appearance of the house of the Société is well shown by the illustrations, but there are several details which demand especial attention. The main auditorium, with its arched girders, is an excellent example of the manner in which constructive features can be artistically treated without concealment, and the lighting and the acoustic properties of the room are also excellent.

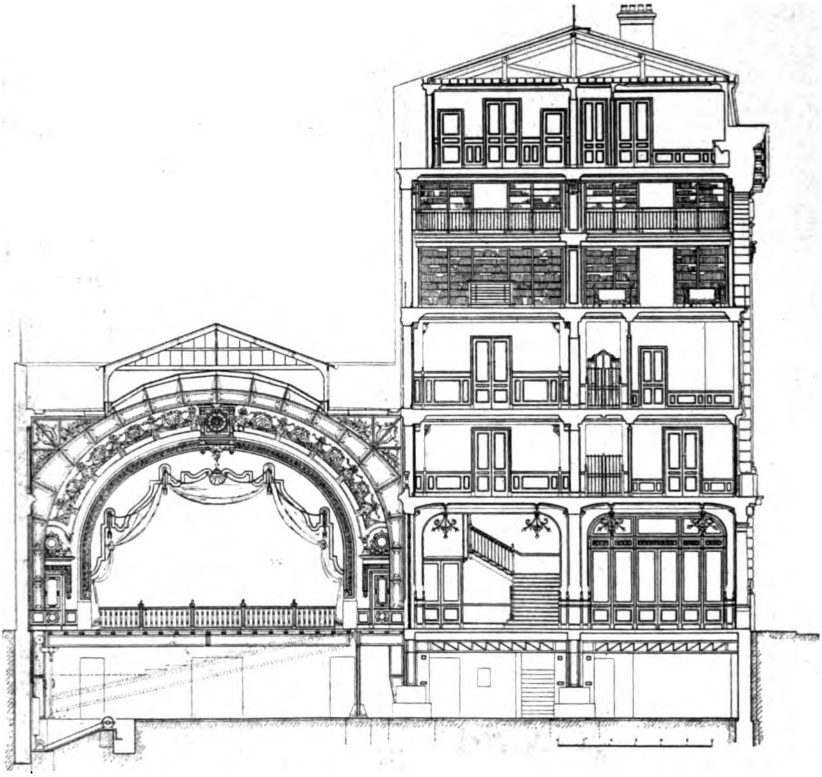
The method of converting the meeting hall from a reception room into an auditorium in the case of the building of the Institution of Mechanical Engineers has already been described, and a similar result is attained by altogether different means in the present instance. The floor of the large hall is supported upon stiff girders which are hinged at the rear end of the room, and counterbalanced by a system of weights and chains at the front, near the platform. By the use of a pair of winches, the floor, weighing about thirty tons, may readily be raised into a level position, being then firmly supported upon adjustable posts; or, in a few minutes it may be lowered into a suitable



SOCIÉTÉ DES INGÉNIEURS CIVILS DE FRANCE.

Main hall, showing the inclined floor. The upper view is from the platform and the lower from the rear of the hall. The curtain is fireproof and separates the annex from the hall when lowered. The gallery at the rear (upper view) forms a part of the smoking and conversation room in the entresol.

incline for use as an auditorium. This convenient mechanism has been found to work exceedingly well in practice.

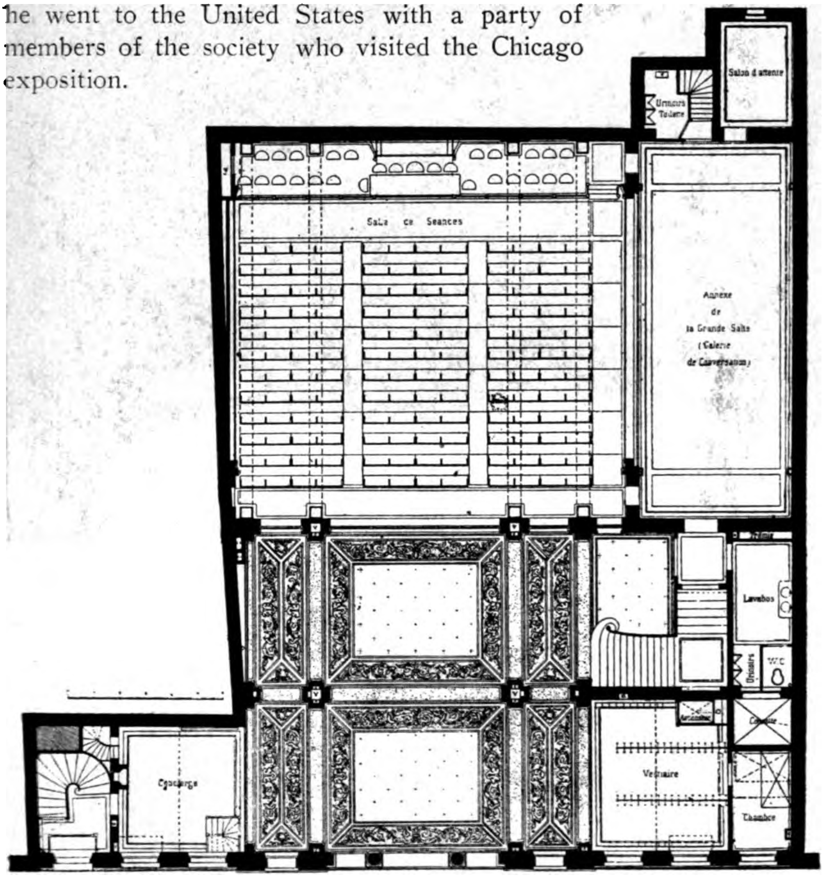


SOCIÉTÉ DES INGÉNIEURS CIVILS DE FRANCE.

Cross section of the building, showing the moveable floor of the meeting hall, and the arrangement of the library and residence of the secretary above the business offices, council room, and general conversation room.

The general arrangement of the building is as follows. In the basement is placed the machinery and the storage space for papers and archives. The ground floor is devoted to the entrance vestibule and lobby and the main auditorium and annexes, with the intention of avoiding the crowding of the main staircase upon occasions of importance. In the entresol are placed the rooms more generally used by the members, including a conversation room, reading and smoking rooms, and a commodious gallery overlooking the auditorium. The floor above is devoted to the business of the society, including the private offices of the president and the secretary, the council chamber, and the general offices for the transaction of business with the public.

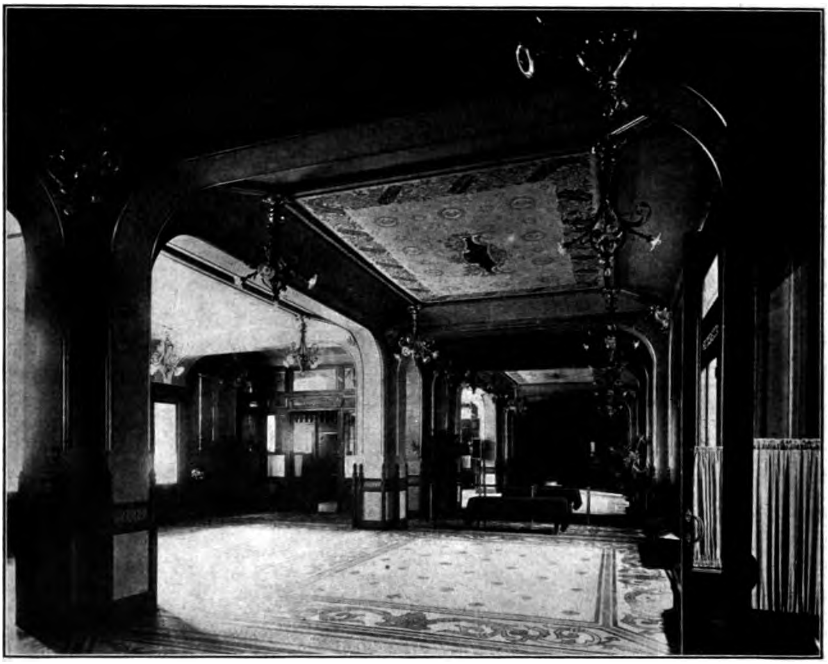
The two floors above are devoted to the library, while the top floor is fitted up as a convenient suite of apartments for the residence of the secretary. A private staircase, with separate entrance from the street, gives access to the office of the president and to the apartments of the secretary, while an electric elevator also gives access to all floors. The main stairway, for the general use of the members and public, forms one of the features of the house, and the artistic decoration of the whole is most effective. M. Armand de Dax, the present secrétaire administratif, who succeeded M. Husquin de Rhéville in 1887, is well and favorably known to engineers in Europe and America, and in 1893 he went to the United States with a party of members of the society who visited the Chicago exposition.



SOCIÉTÉ DES INGÉNIEURS CIVILS DE FRANCE.

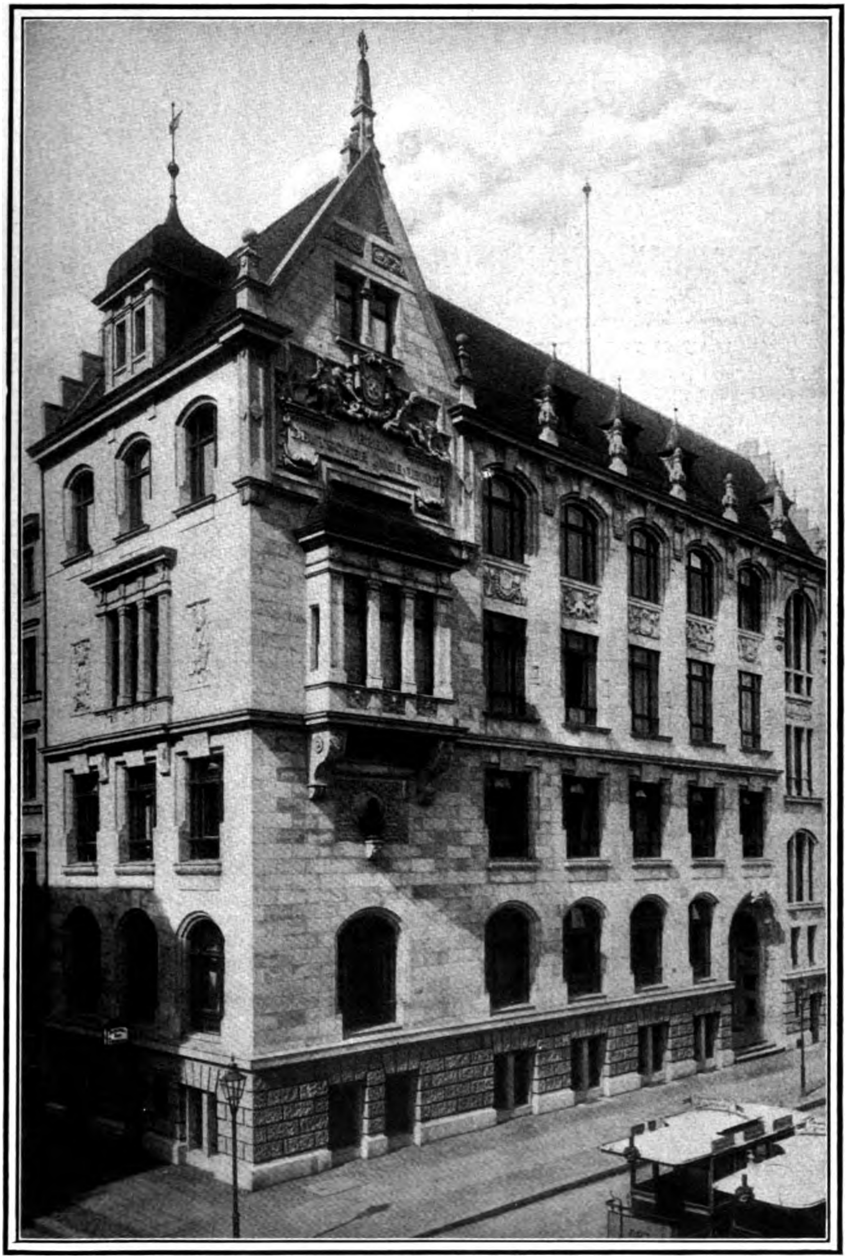
Ground plan, showing lobby, meeting hall, coat room, staircase, etc. This arrangement permits of receptions, meetings, and the like, without the use of any stairway whatever, the receiving line being in the inner lobby after leaving the coat room and before reaching the main hall.

The Verein Deutscher Ingenieure differs materially in its composition and methods of work from any of the other national engineering societies, and hence its requirements are by no means the same as obtain in London or Paris. The system of "Bezirksvereine" or local branches in various cities and districts of the empire provides for a large portion of the professional activity of the society, and the general meetings are held yearly in different cities, so that a large general meeting hall in Berlin is not required, provided sufficient accommodation for the local branch is made. Furthermore, the society publishes what is undoubtedly one of the most complete and valuable weekly engineering periodicals to be found in any country, this including the more important contributions presented at the meetings of the society, together with additional papers and articles, and general current engineering information. This renders the editorial feature of the work of the secretary a preponderating feature, and Baurat Peters, the energetic and experienced director of the society, has shown himself most efficient in this important portion of the work. With a

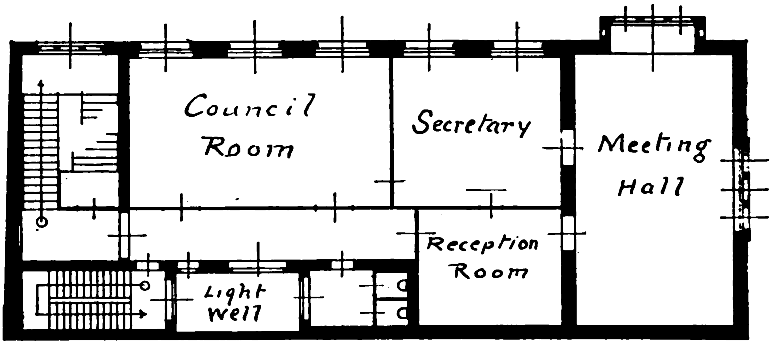


SOCIÉTÉ DES INGÉNIEURS CIVILS DE FRANCE.

Inner lobby, showing the effect of the great mirror. The street entrance is on the left and the entrance to the main hall on the right, the view being taken from the base of the grand stairway.



THE VEREIN DEUTSCHER INGENIEURE.



PLAN OF THE SOCIETY ROOMS, VEREIN DEUTSCHER INGENIEURE.
The floor above is occupied by the editorial offices of the *Zeitschrift,* and the top floor by the photo-engraving plant. The lower floors are given up to residence or business purposes.

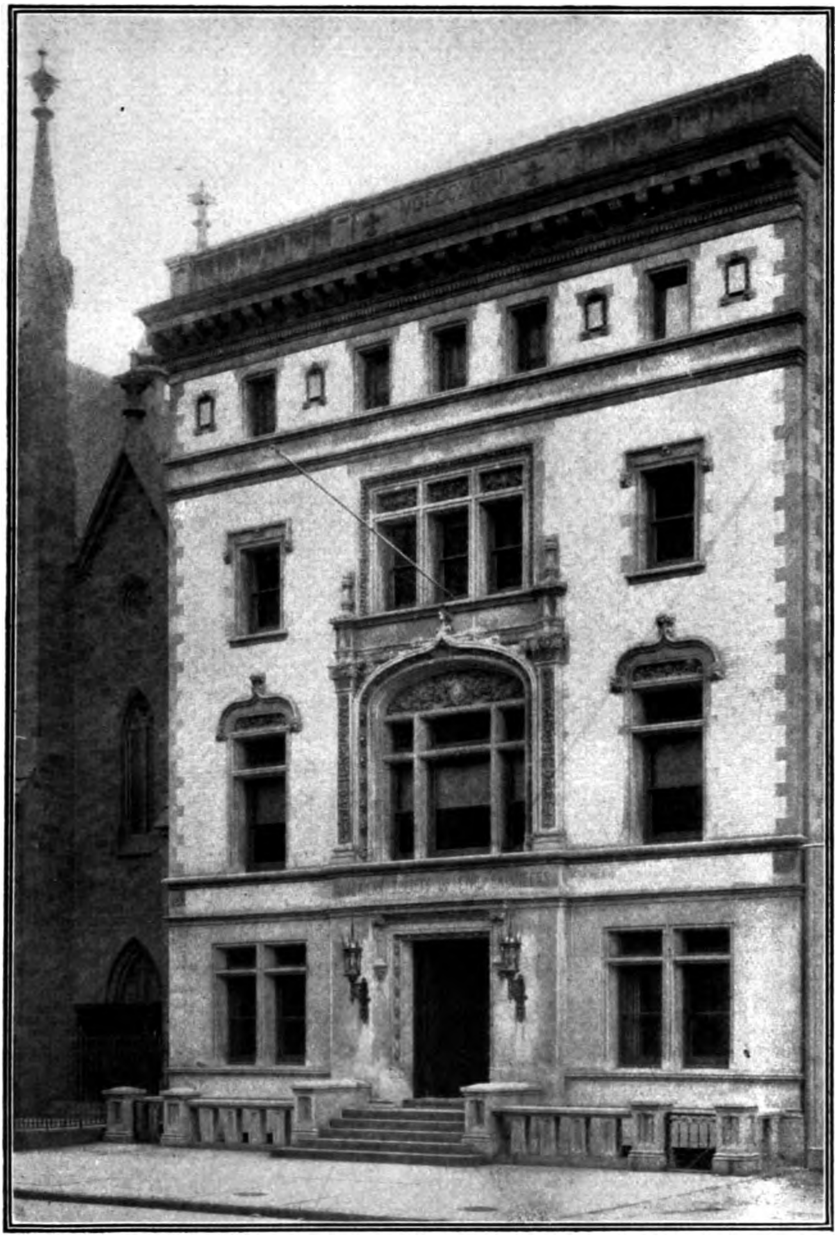
total strength of more than 17,000 members covering practically all branches of the profession, and with 42 local working sections in all parts of the empire, as well as more than 4,000 members not attached to local branches, the Verein Deutscher Ingenieure is without doubt the largest and most active engineering society in the world.

Its annual conventions being held in various cities, no especial provision is made in the new building at Berlin for the accommodation of anything like the full attendance on such occasions. The headquarters are rather a set of working offices for the administration of the society's affairs, for the editorial department of the *Zeitschrift,* and for the meetings of the Berlin section.

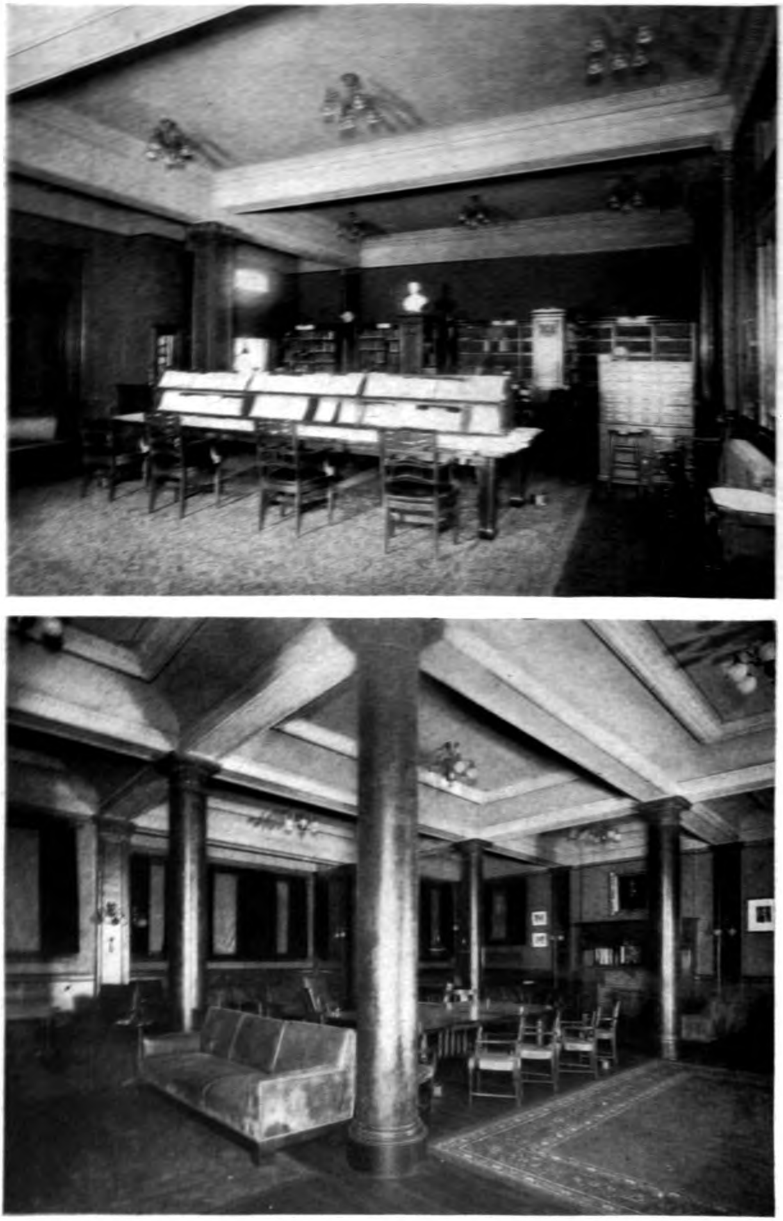
The new house of the "Verein" is a handsome sandstone structure situated on the Charlottenstrasse, one of the most desirable streets of Berlin, and is an excellent example of a business headquarters for such an organization. The basement is fitted up for storage purposes, while the ground floor and floor above are arranged to be rented for business purposes, thus bringing in a substantial income.

On the second floor is situated the meeting room, of ample size for the needs of the Berlin section, and on this floor are also found rooms for the meetings of the directors, as well as suitable waiting rooms. The third floor is wholly devoted to the editorial rooms of the *Zeitschrift,* while above are reading and drawing rooms and a photographic studio.

The only one of the four National engineering societies in the United States which possesses a building especially designed and constructed for its use is the American Society of Civil Engineers, this hansome structure being situated on West Fifty-seventh St., in New



THE AMERICAN SOCIETY OF CIVIL ENGINEERS.



THE AMERICAN SOCIETY OF CIVIL ENGINEERS.

The lower picture shows the board and committee room, used also as a reception room. This is directly below the main meeting room. The upper view is the main reading room of the library; the stack room is above.

THE CORRIDOR, HOUSE OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS.

At the rear is seen the board and committee room, above which, on the next floor, is the main meeting hall. The library is over the corridor.

York. The house is arranged as shown in the illustrations, with entrance lobby, coat room, and reception rooms on the ground floor, while back of these is a large room, originally designed as a lounge and smoking room, but since used for the board and committee room.

The first floor contains the main meeting hall, directly over the board room, and also the reading room, and the office of the secretary, while on the two floors above are situated the executive and editorial rooms and the book stack of the library. The current periodicals, as well as certain books of reference and new books are kept in the reading room, while the dumb-waiter connection to the top floor enables books from the stack to be supplied promptly upon call.

Electric lighting is supplied from an isolated plant in the basement, there being two gas engines of 25 horse power each, with direct-connected dynamos.

The area of the ground on which the building stands is 50 feet front, by 110 feet deep, and the total cost of house and ground is a little more than $200,000.

THE LIMITS AND POSSIBILITIES OF DEEP MINING.

By E. H. Roberton.

No better suggestion of the importance of deep mining could be supplied than that provided by Professor Redmayne's articles on the coal industry, which appeared in our October, November, and December issues. The question of fuel exhaustion depends largely on the depth to which the coal deposits of Great Britain can be worked. Elsewhere, as at Lake Superior and on the Rand, the subject has immense importance in metal mining. Mr. Roberton deals instructively with the mechanical aspects of the problem.—The Editors.

THE exhaustion of the more superficial deposits of coal and other minerals brings into prominence one of the most interesting latter-day problems of scientific engineering—the study of the limits and possibilities of deep mine work. The difficulties with which the mining engineer has to contend are, briefly, the increases in temperature and pressure due to depth, and the various mechanical problems connected with the economical extraction of the mineral. Of these it is probable that the natural forces of temperature and pressure will prove the more formidable.

Although it is true that in the deep levels of the Tamarack mine, in the Lake Superior district, the temperature at a depth of over 5,000 feet is quite moderate, being only 78 degrees, it is unfortunately also true that in the deep mining practised in other districts, experience goes to prove a steady increase in temperature as the mine proceeds to depth. Great stress is being laid on the subject of the temperature of deep mines, by the Royal Coal Commission, now sitting, and the evidence so far adduced points decidedly to a limit to deep mine work on that score alone. The rate of increase of temperature, however, varies even for the same locality in a bewildering way. This will be seen on reference to the chart, where the records taken at different times, in the same mine workings, trace curves that prove to be quite different from each other on the chart.

At Pendleton Colliery, where the workings have reached a depth of 3,500 feet, the temperature of the working places is as high as 93 degrees, and that of the rock itself is 100 degrees. The rate of increase in the inclined bed of this mine is 1 degree for every 40 feet of descent. This is an exceptional case, and much above the average. At a sinking at Rosebridge Collieries, near Wigan, the increase of tem-

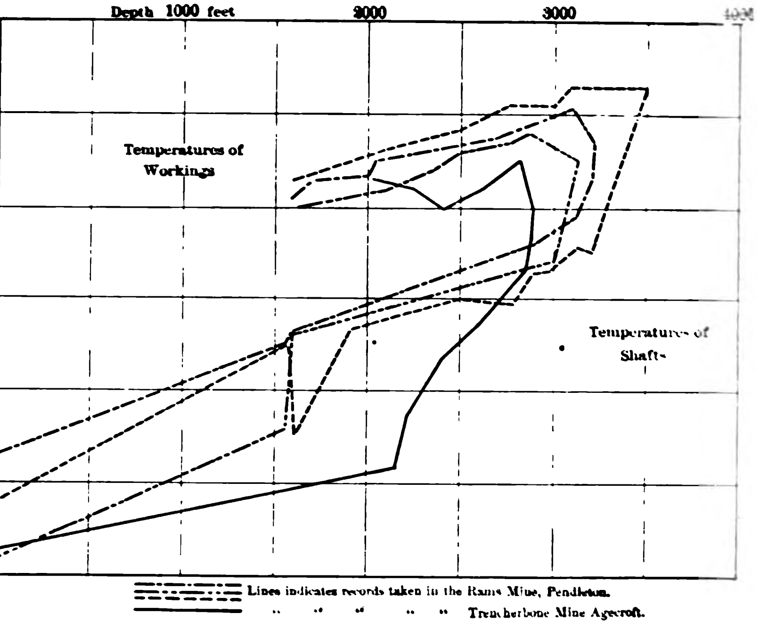


CHART SHEWING UNDERGROUND TEMPERATURE OBSERVATIONS.

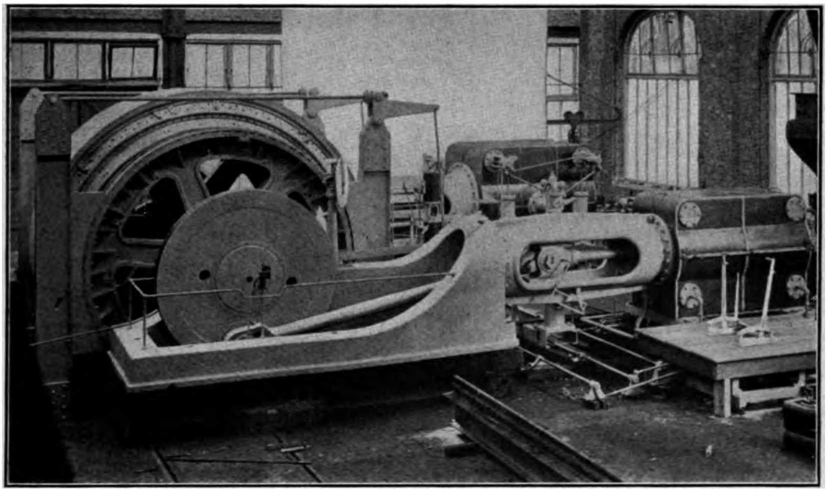
re of the rock was 1 degree for every 55 feet, and at a depth of
feet, the temperature was 94 degrees. On the other hand, in
sinkings the increase is much less, often about 1 degree in 80
hile at Niddrie Colliery, Portobello, the increase is only 1 degree
feet, the temperature at a depth of 2,623 feet being 74 degrees.
e workable limit of temperature depends largely on the dryness
air. At Pendleton, even where the temperature is 93 degrees,
or no inconvenience is felt from the heat, as the atmosphere is
, and it is thought that the workmen will be able to stand even
egrees. In the case of a moist atmosphere, however, a much
temperature will be found insupportable.
e use of compressed-air machines and drills in the mine is of
value in reducing the heat, and no doubt this will be an im-
t factor in favour of the adoption of compressed air rather than
city in deep mines. Liquid air has been suggested as a means
ificially cooling the atmosphere in the working places, and may
tely prove of value. The use of large shafts, 20 feet and up-
in diameter; the construction and upkeep of capacious air-ways;
he maintenance of a thoroughly efficient ventilating current
ghout the mine, will, however, best aid the mining engineer in
ntrol of the temperature.

The great pressure due to the increased depth at which minerals are worked at the present day, is in the case of coal mines gradually rendering the old "bord-and-pillar" system of working obsolete. The 70 or 75 per centage of coal left in the form of pillars has to bear the same weight of superincumbent strata as lay upon the original untouched coal seam. When mines were shallower, the pressure was not sufficient to crush the coal excessively, but was generally enough to make it much more easily workable at the second working. Now, however, the increased pressure is proving too much for the pillars that are left, and crushes them so severely as to render the coal unmarketable, or even to lose the mine. In all cases resort is made to the more modern system of "long-wall" working, the system whereby the coal is removed in one working, slice by slice, from a long face or "wall," the roof gradually subsiding on to packing placed to receive it. It speaks volumes for the ingenuity of mining engineers to find that not only does this enable the coal to be got in a marketable condition, but that the very pressure which before crushed the coal to slack is now made to aid in the working of the coal, and that the coal can be got at a cheaper hewing cost in a deep than in a shallow mine.

The consideration of roof and floor is a very important point, as even at a very great depth a seam can be worked without any serious difficulties, provided the roof and floor are of good hard sandstone. Sandstone, too, affords excellent packing for the wastes. In the Niddrie collieries, at a depth of only 1,200 feet, a seam which was overlaid by soft shale was rendered unworkable by the method of bord-and-pillar, as no sooner was an opening made than it began to fill up with the shale from the roof. On the other hand, at a depth of 2,600 feet no particular trouble was experienced in the working of a 5-foot seam by long-wall, the roof and floor being of harder rock.

As a coal mine proceeds to depth, there is more frequent danger from "blow-outs" of the coal. The pressure of the strata, probably assisted by pressure of gas, causes the coal seam suddenly to give way in some weak spot, and several tons of coal and slack are projected out from the face with great violence, sometimes burying one or more unfortunate hewers. These outbursts in some seams occur at a depth of 600 feet, and in others do not take place until after a depth of 3,000 feet has been reached.

Occasionally the engineer is enabled to make use of some natural advantage at his disposal. For instance, in the Rams mine at Pendleton, there is a layer of soft dirt above the seam, which the miner



CROSS-COMPOUND WINDING ENGINE AND DRUM FOR THE SHERWOOD COLLIERY CO.

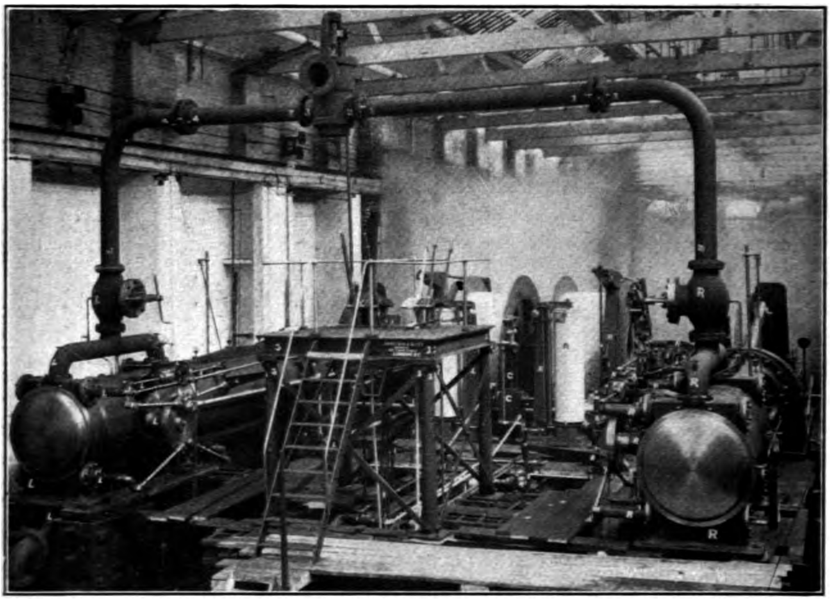
The drum is cylindrical for three revolutions, then conical for two revolutions, and cylindrical for the rest of the wind. Built by Fraser & Chalmers, Ltd.

scrapes out. This relieves the coal from the top pressure, and the bottom pressure forces it up and breaks it off in large pieces, saving the miner this trouble. It is interesting that from this seam at a depth of 3,500 feet, a piece of coal weighing 25 hundred weight was got for the Coronation Procession. When this can be done at 3,500 feet, who shall say where the limit must be put to the depth to which the colliery engineer can penetrate?

In metal mines, where the hanging and foot walls are often very hard rock, pressure does not seem to threaten to be a very serious item. Crumbly rock, and rock that weathers rapidly, is much more difficult to deal with than tough, weather-resisting material. In the Lake Superior district the copper ore is mined at a depth of more than 5,100 feet, and is likely to proceed much deeper, while on the Rand there is every possibility of the gold reef being worked at a depth of 6,000, or even 8,000 feet. In both these cases the hanging and foot walls are of hard rock.

The problem of deep winding affords a special interest to the Midland counties of Great Britain, where there is a probability of the hidden coal seams being worked ultimately to great depth. Professor Redmayne, in an address delivered a short time ago, said that the colliery of the future, by means of three or four shafts, and with a total of 25,000 horse power, will draw from a depth of 4,000 feet a daily output of 12,000 tons.

The great cost of sinking a pair of deep shafts, and of a modern colliery equipment, necessitates a proportionately large output. This must be ensured by rapidity of winding, and the raising of a heavy net load at each trip. The operation of winding may be carried out in a single lift from the pit bottom to the surface, which may be termed single-stage winding; or it may be effected by winding from the bottom to a stage in the middle of the shaft, and from thence to the surface (double-stage winding); or the number of stages may be extended to three, and even more.

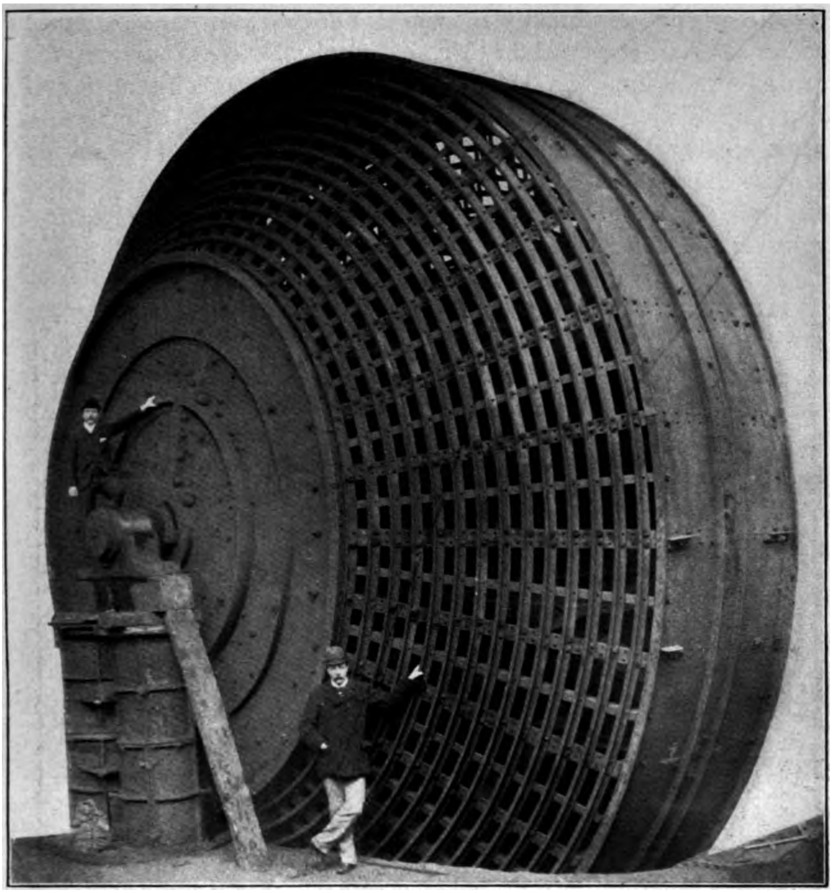


HIGH-PRESSURE HORIZONTAL WINDING ENGINES, FOR WINDING 64 CWT. FROM A DEPTH OF 3,000 FEET.

Cylinders 24½ inches by 6 feet. Average speed 1,500 feet per minute. Built by Robey & Co., Ltd., for the Great Boulder Prop. Gold Mines, West Australia.

In single-stage winding, owing to the great length of rope, the dimensions of the drum are exceedingly difficult to keep within bounds, as either the breadth of the drum and the consequent angling of the rope are excessive, or the diameter of the drum is so great as to cause too much increase in its moment of inertia, besides lowering the piston speed of the engines, and preventing them getting into their stride quickly.

The weight of the rope, owing to its great length, is a serious difficulty, and various methods of balancing this dead weight have been tried. Conical and spiral drums are in great favour, and it is

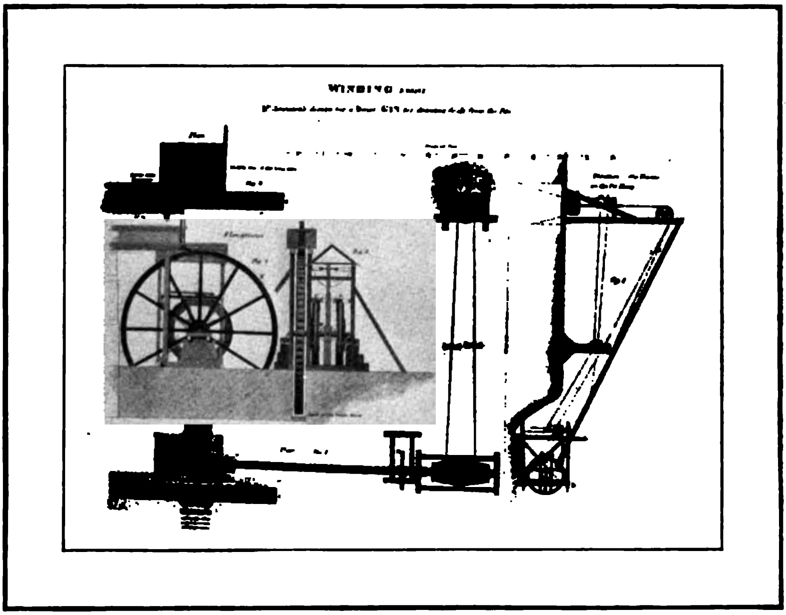


BUILT UP STEEL SPIRAL DRUM, TO WIND 4 TONS NET FROM A DEPTH OF 2,289 FEET. Diameters 18 to 33 feet; shaft 24 inches; weight of drum alone, 80 tons; built by Robert Daglish & Co.

interesting to note how these recall the devices of nearly a hundred years ago. In an ancient mechanical winding apparatus, driven by water power (see next page), a conical drum was designed by Mr. Smeaton, about the year 1810; and in the early days of steam winding, flat ropes or chains were used which coiled upon themselves on a reel, in exactly the same manner as the tape in a tape measure. This latter device served the same end as the spiral drum, but the cost of the ropes was very great. Short sections of these ropes are shewn on page 553. At Shut End colliery, near Kingswinford, a chain winding plant of this type was erected about 1828, and is still in use (see page 553), the depth from which it winds being about 730 feet.

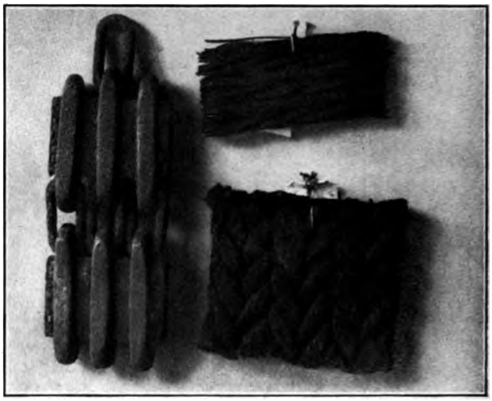
In 1896, an interesting plant was laid down at No. 2 pit, Preussen colliery. This consisted of Mr. Tomson's device of dividing his conical drum into two halves, and mounting each on a separate shaft; by this means avoiding a single shaft of unwieldy proportions, while keeping the diameter of the drum within bounds. (Page 555.)

The difficulty of avoiding excessive angling of the rope, and yet employing an engine and drum of moderate size, when winding from the great depth of 2,700 feet, was overcome by Mr. W. Morgan in a most ingenious manner. The drum, as was natural, had to be built of unusual length, in order to hold the requisite number of coils of rope. Mr. Morgan mounted both engines and drum on a travelling carriage, which traversed a distance equal to the diameter of the rope, with every revolution of the drum (see Figure 9). Angling of the rope was by this means entirely obviated.



SMEATON'S DESIGN FOR A WATER-POWER WINDING GIN, SHOWING CONICAL DRUM.
From an old drawing.

One of the most ingenious attempts, and by no means an abortive one, to solve the problem of deep winding, was that of M. Blanchet in fitting the Hottinguer shaft at Epinac with his pneumatic system of winding. The shaft was intended to attain a depth of 3,300 feet, but owing to the lack of workable coal was stopped at 2,130 feet. M. Blanchet's chief motive for the adoption of this system at Epinac

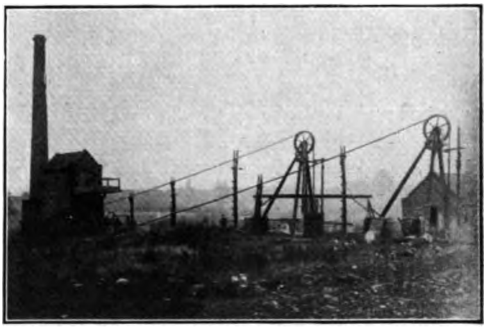


OLD FLAT ROPES AND CHAIN, FORMERLY USED FOR WINDING.

was to enable the pit to start work immediately on the completion of the first shaft, without waiting for the sinking of the second shaft, and yet to ensure good ventilation. This meant in the case of the Hottinguer pit a saving of five years. It is unfortunate that the fact of no workable coal being found in the shaft gave the plant no opportunity of operating on a large scale. It was sufficient, however, to shew that the system was thoroughly workable, and in spite of the great initial cost, to be expected in an experimental installation of the kind, could be made a practical success.

In view of the heat of the deep strata, M. Blanchet decided not to increase this heat by compressing the air in the tube, and so heating the shaft, but to exhaust the air, drawing the load up by suction, which would have a cooling effect on the air going down the shaft. The tube, which was of wrought iron, 63 inches in diameter, in lengths of about 20 feet, was hammered round upon a special mandril, and placed at one side of the shaft. The cage, which has nine decks, and carries over 4½ tons of coal, is slung below two pistons and above a third, as shewn on page 554, while beneath all is a parachute, in case of accident. Three cages can be loaded or unloaded simultaneously, the valves to connect the tube with the exhausting engines or the outer atmosphere being operated by the onsettors and banksmen.

It is highly probable that we have not seen the last of the pneumatic system of hoisting. Its advantages in connection with deep shafts are

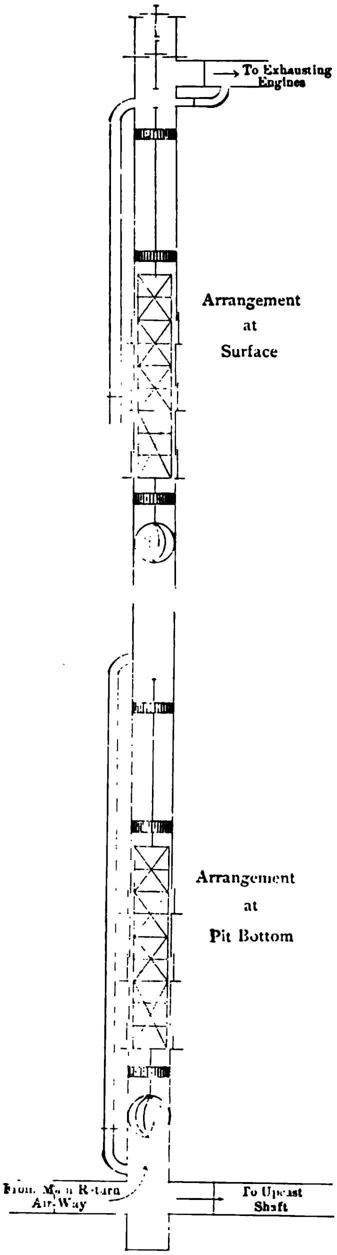


AN OLD COLLIERY, WITH FLAT WINDING CHAINS STILL IN USE.

numerous. The method can be practised with as great facility in mines of enormous depth as in shallow mines, and the winding rope, which in a deep mine is a very expensive item, and a constant drain on the resources of the concern, is entirely dispensed with. A large load can be dealt with at each trip, and the speed of the cages, especially in the descending trip, is almost unlimited. Ventilation is assisted, and the air in the downcast shaft is cooled (if exhausting engines are used)—a great gain to the engineer who is anxious to reduce the temperature of the working places in his mine. Last, but not least in importance, repairs can be carried out in the shaft without interfering with the raising of the mineral.

Taper ropes are being considered by mining engineers, as a means of lessening the masses to be set in motion by the engines, but their cost is very great. One of the first applications of the taper rope was made at Przibram, about 22 years ago, in a shaft 3,900 feet in depth. It is said that the ropes lasted 3½ years, making 100,000 trips a year. It is more usual and less expensive to have a long winding rope made in lengths of 500 feet, or more, joined together, the section of each length being less than the one above it. This answers the same purpose as a taper rope, and the average weight per unit length is not much greater.

The efficient balancing of the winding rope makes greatly for economy in engine and boiler power, as the static load throughout the wind is



BLANCHET'S PNEUMATIC HOIST.

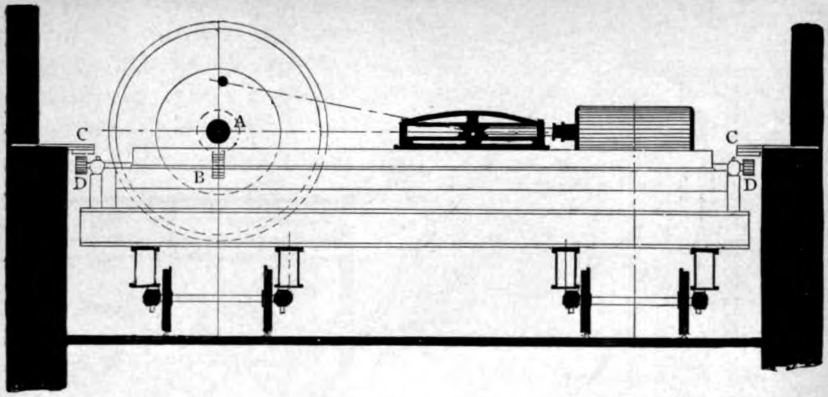
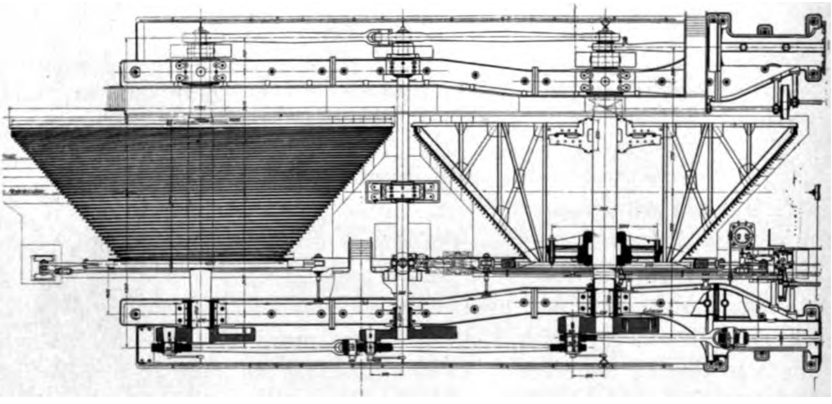


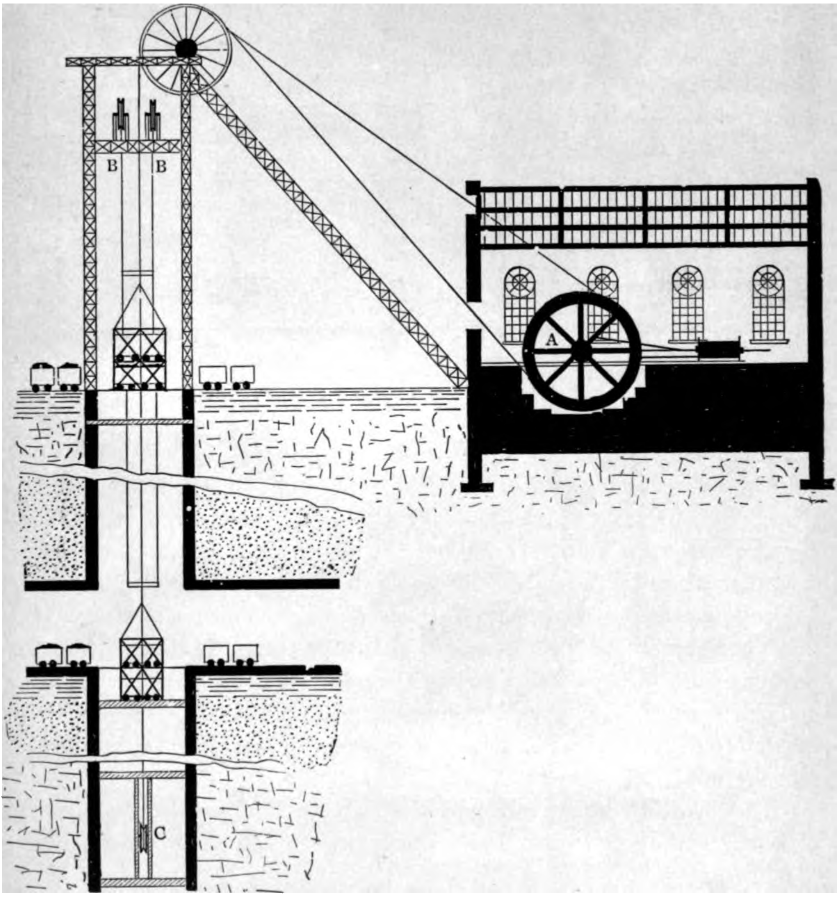
DIAGRAM OF MORGAN'S TRAVERSING WINDING ENGINE FOR PREVENTING ANGLING OF ROPE.

constant, and equal to the weight of mineral raised. The best known modern method of balancing the rope is the Koepe, introduced by Mr. Koepe at Hanover Colliery, Westphalia, which employs a tail rope under the cages. The winding drum is dispensed with, its place being taken simply by a driving sheave, about which the rope passes. Two sheaves are used in the Whiting system, which is a development of the Koepe, the principle being similar. The comparative lightness of the driving sheaves, and the absence of heavy coils of rope revolving with the drum, give a correspondingly diminished moment of inertia, with the result that engines of less power may be used.

The Whiting hoist, which is used at the Red Jacket shaft of the Calumet and Hecla mine, Lake Superior, at Kimberley, and at some



TOMSON'S METHOD OF DIVIDING A CONICAL DRUM TO PREVENT UNWIELDY SIZE OF DRUM SHAFT.



KOEPE SYSTEM OF WINDING.

A, winding sheave, about which the main rope takes a half turn; B B, auxiliary ropes to prevent damage in case main rope breaks; C, pulley in sump about which tail rope passes.

gold mines on the Rand, has an ingenious arrangement by means of which it can wind from different depths. At the Calumet and Hecla mine, the difference between the depths from which the engine can wind is more than 1,200 feet. (See page 557.)

The results obtained by simply attaching a tail rope under the cages, and winding with a drum in the usual way, are well worth the attention of engineers. In one case, the addition of a tail rope in a pit 1,260 feet deep reduced the effective horse power required by 11 per cent.

There are several ingenious methods in use of balancing the winding rope, other than by attaching a tail rope. The method in use at Camphausen, where the main shaft is nearly 2,000 feet in depth, requires an auxiliary shaft of about 250 feet. A diagram explanatory

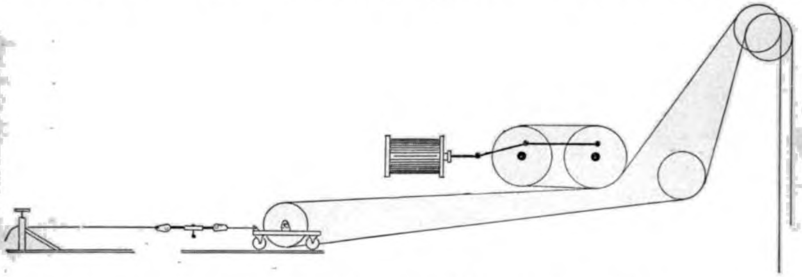
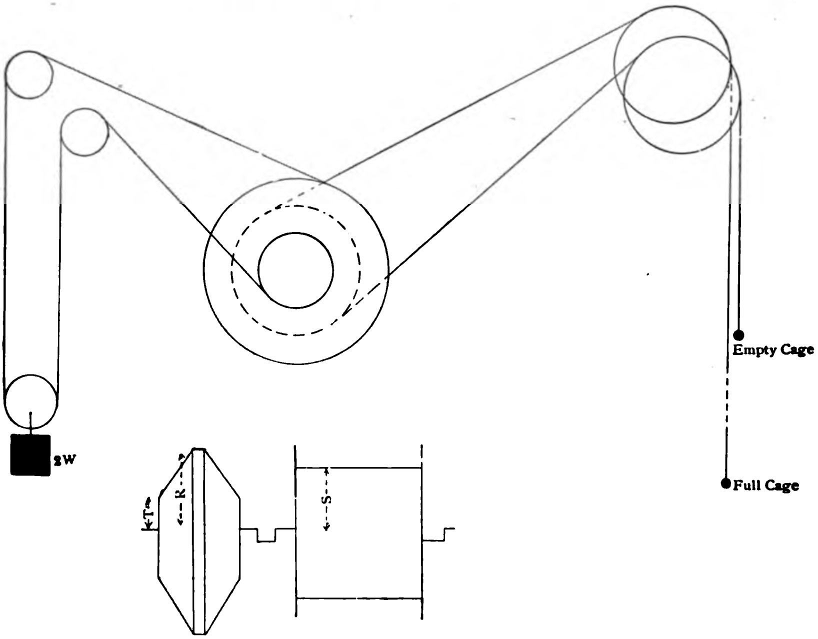
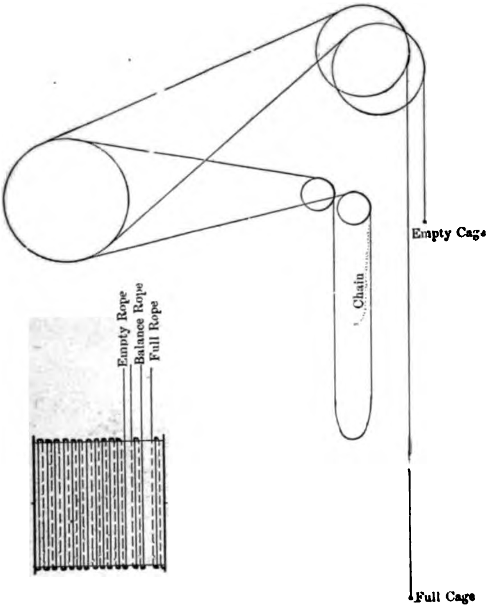


DIAGRAM EXPLANATORY OF WHITING HOIST SYSTEM.



BALANCING THE ROPE, CAMPHAUSEN METHOD.

of this device is shewn just above. A supplementary spiral drum is mounted on the main drum shaft, and the rope from which the balance weight in the auxiliary shaft is suspended unwinds itself on the descending side, and winds itself at the same time on the ascending side. Thus the arrangement is "differential."



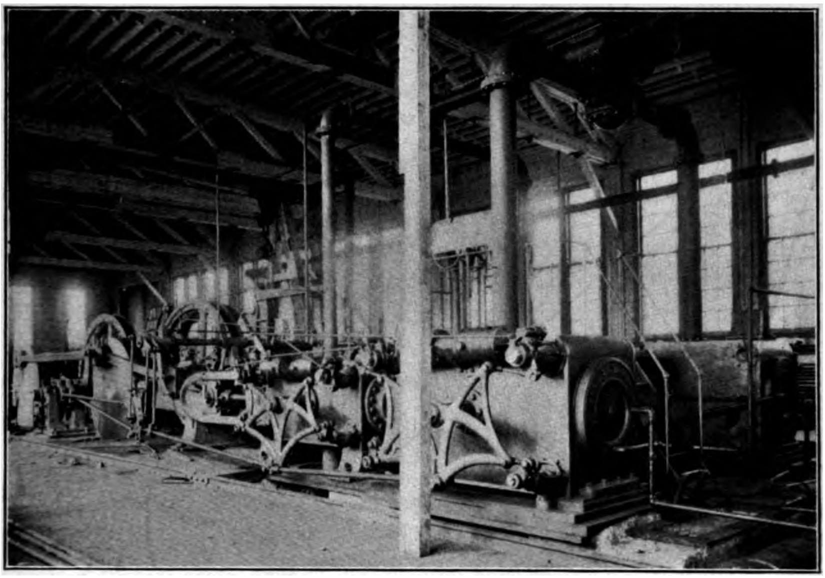
BALANCING THE ROPE, DESPRÉS' METHOD.

If R and r are radii of the spiral drum, and s the radius of the main winding drum, and 2W and w the weights of the balance weight, and the unbalanced rope respectively, then for equilibrium of rope at commencement of wind, (R—r) W = sw.

In the method invented by M. André Desprès, a cylidrical drum is used, and the auxiliary rope to which a balancing chain is attached is given one or two turns round the drum. its place on the drum being between the full and empty ropes. This rope (endless) passes down a special compartment of the shaft to half the depth of the shaft, and comes back to the drum. A chain is slung on a pivot a quarter of the way down the shaft, and is fixed to the auxiliary rope in such a way that the other end of the chain is at the top of the shaft at the beginning and end of each wind. This of course assists the engine at the beginning, and the brakes at the end of each trip.

Although the balancing of the static load is an excellent thing, it is improbable that engineers will rest until the balance of the dynamic load is effected. The increase of power required from the engine during the acceleration period is often as much as 50 per cent. above the average power required for the whole wind, and when the period of rest is taken into account the discrepancy is still greater.

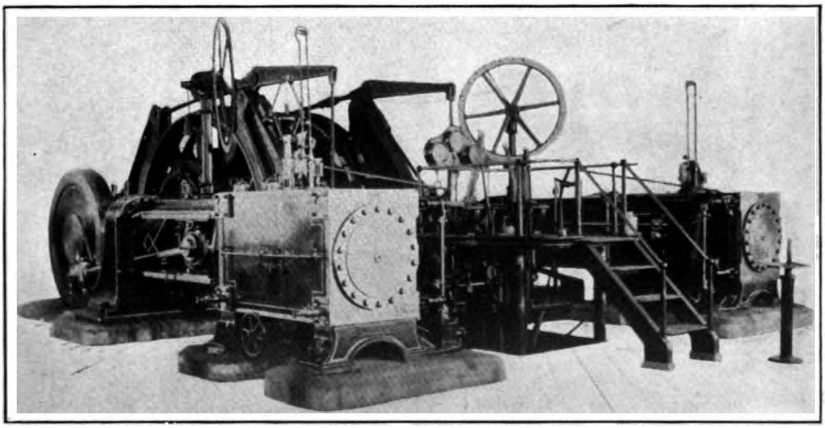
To take an extreme case, suppose it to be required to raise 100 tons an hour from a depth of 4,000 feet, with unbalanced taper ropes, and a cylindrical drum, at a single lift. Then if the initial acceleration were 4½ foot-second units, the effective horse power required during the acceleration period would be about 2,000, while if averaged over the whole hour it would only be 600. The reason of the discrepancy is that acceleration must be created not only in the load, but also in the masses of the drum, cranks, pit-head pulleys, and ropes,



WHITING HOIST, THE TYPE LARGELY USED IN THE MINES OF THE RAND.
Built by the Allis-Chalmers Co., Chicago.

and at the end of each run the kinetic energy stored in these must be destroyed, either by brake power, or by turning the steam against them, or as is usually the case, by both.

It is evident that if the energy of a steadily running engine were stored up in such a way that the store could be drawn upon as re-

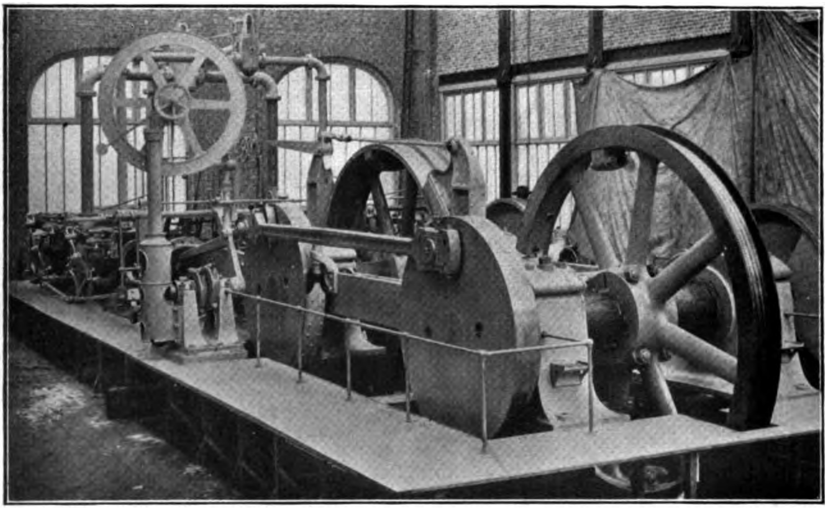


FIRST-MOTION WINDING ENGINE, WITH DOUBLE REELS.
Rocky Mountain type, for flat ropes; drums secured to shaft by heavy band-friction clutches and controlled by powerful post brakes of gravity type. Wellman-Seaver-Morgan Co.

quired, the solution of the problem would be within sight. It may come by means of electrical, hydraulic, or pneumatic agency.

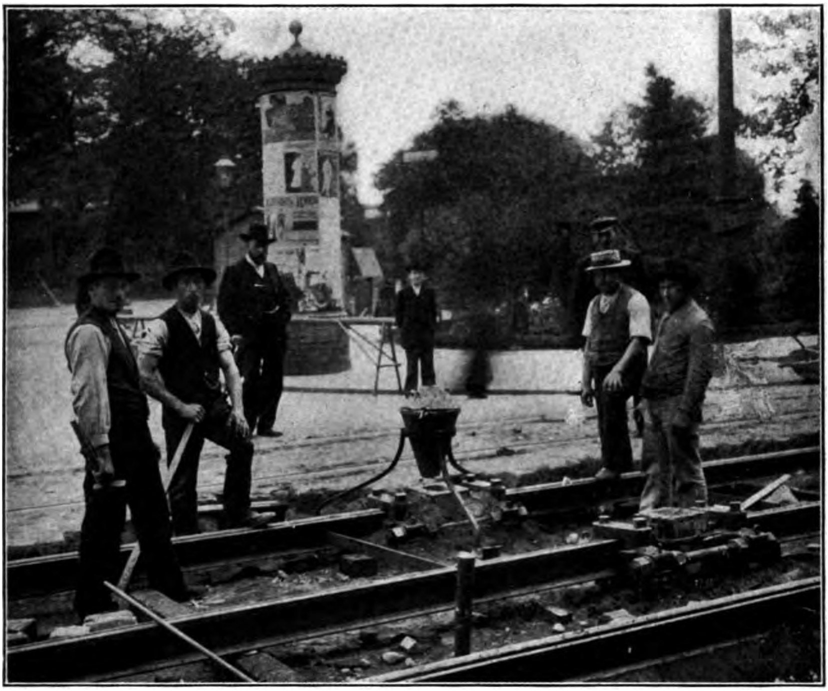
There is a strong tendency at the present day to "electrify" large works by means of a central generating plant which supplies all the machinery with power. Professor Redmayne states that, in his opinion, the great mining concerns of the future will be supplied with power from a central generating plant, driven by "producer-gas" engines, and that possibly three or four different mining companies will join forces to build a common generating plant which shall supply them all. The power thus derived will drive all the machinery, including winding, hauling, drilling and undercutting, screening, washing, etc., and will also light the mines. The economy of power thus attained will probably afford the solution of the deep-winding problem.

Hydraulic accumulation of power does not seem to lend itself to the equable expenditure of power throughout the operation of winding, excepting perhaps as a balance weight, but the pneumatic system, introduced by M. Blanchet, will apparently call for more than passing notice. Whether compressing or exhausting, there is no reason why the engines should not be kept running steadily through the whole working day; while for ease of application to mines of enormous depth, it is beyond comparison with rope-winding systems.



WHITING HOIST, BUILT BY FRASER & CHALMERS, LTD.

Showing the winding end. The steam end is shown on the preceding page.



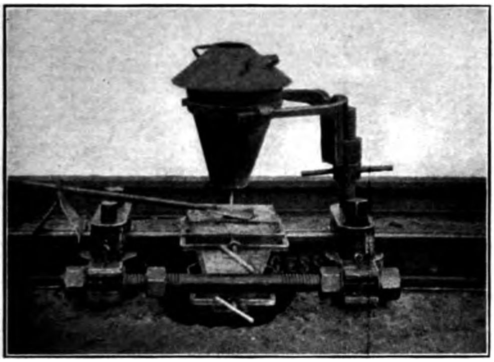
WELDING TRACK AT DRESDEN, SHOWING THE CLAMPS AND MOULDS AND CRUCIBLE READY TO IGNITE AND POUR.

MECHANICAL AND METALLURGIC APPLICATIONS OF ALUMINOTHERMICS.

By Emile Guarini.

The process described in the following pages, as said in the conclusion of the article, is one which is capable of ministering greatly to the convenience of mechanical and structural work—especially repair work. In that respect it has been thought worthy the attention of the largest engineering societies, and in the same spirit it is described here.—The Editors.

TO make cast iron anywhere at will, without fuel and with the minimum of equipment; to cast all kinds of metals with the aid only of a match; to make the metals serve for their own fusion—these possibilities are surely by no means commonplace, and the opportunities for practical application they afford are many. And yet this is scarcely an over-dramatic description of the results attained by "aluminothermics." The reaction upon which they are based, dis-



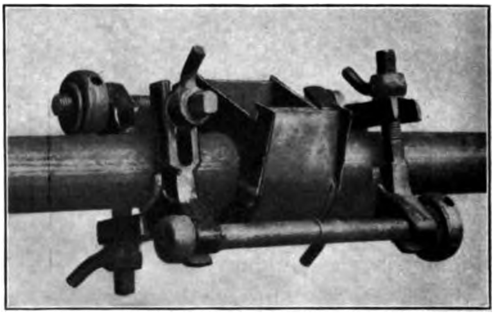
COMPLETE OUTFIT FOR RAIL MOULD.

covered by Dr. Goldschmidt, of Essen, is as follows: if a mixture of pulverized aluminium and a metallic oxide be ignited at a single point, combustion proceeds without further supply of external heat, without any combination with the atmospheric oxygen, and with the development of a temperature estimated at 3,000 degrees centigrade. The reaction reduces the oxide, yielding the metal pure and free from carbon, and leaves a scoria of aluminium oxide, or artificial corundum.

In industrial practice the oxide of iron is naturally the one most often used. The mixture of aluminium and ferric oxide has been given the commercial name "thermite," and for convenience this term is employed in the following brief description.

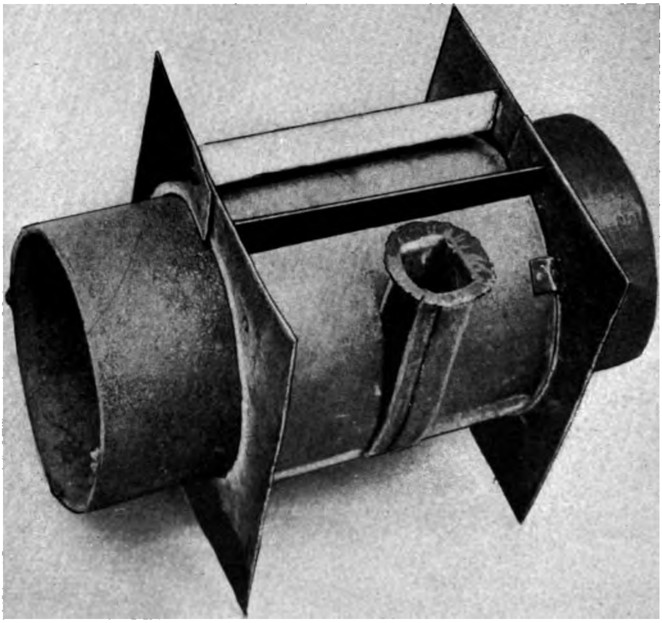
Thermite on combustion yields a soft homogeneous iron, which on account of the high temperature to which it is raised has the property, when poured upon a metal part which is to be repaired, of softening the surface over which it flows and uniting intimately with it.

The reaction is carried on in special crucibles made of sheet iron lined with magnesia. The corundum may be decanted, or the iron poured from beneath by unstopping a hole prepared in advance in the bottom of a so-called "automatic" crucible of conical form. To light the thermite, the crucible must first be thoroughly dried. Into it are then poured a few teaspoonfuls or many kilogrammes of thermite, according to the requirements of the operation to be performed. Upon the top of this is then placed a small pile of a firing powder made of aluminium and peroxide of barium. The operator, hav-



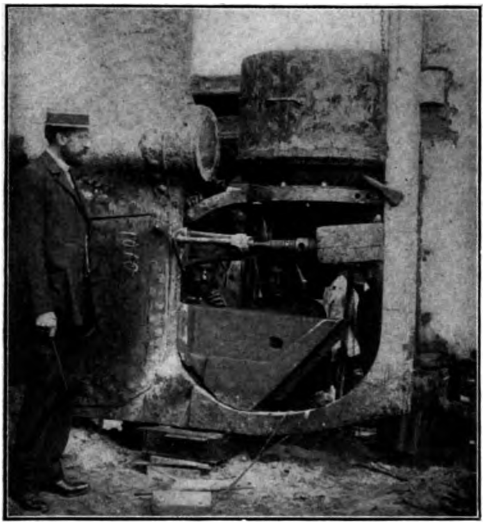
WELD MOULD FOR HORIZONTAL TUBES.

ing put on a pair of smoked glasses, then fires the powder by means of a match fuse or a bar of iron heated red-hot. The reaction of the thermite begins at once and is complete in less than a minute. More of the reagent may be added during the reaction, if needed. The iron produced may be improved by adding to the thermite about 0.3 or even 0.5 per cent of ferro-silicon. Manganese or titanium may also be added. The addition of 100 to 250 grammes of pig iron per kilogramme of thermite yields a hard, fine-grained, and very malleable steel. With a large increase in the amount of iron added, the resultant product is a hard, malleable tool steel. Titanium may of course be added to this mixture.



MOULD FOR BRAZING TUBES OF LARGE CALIBRE

Besides iron, the process may be used for the production of many alloys and other metals, free from carbon, a result not heretofore attained even by the electric furnace. Among the more important of these products are manganese, chromium, and the alloys ferro-titanium, ferro-boron, ferro-vanadium, mangano-titanium, etc. Finally, the corundum which is produced finds application for use in making



REPAIRING STERNPOST OF THE SEBENICO, TRIESTE, JUNE, 1903.

Fracture 120 by 200 mm. Engraving shows longitudinal section of mould box, and crucible in place.

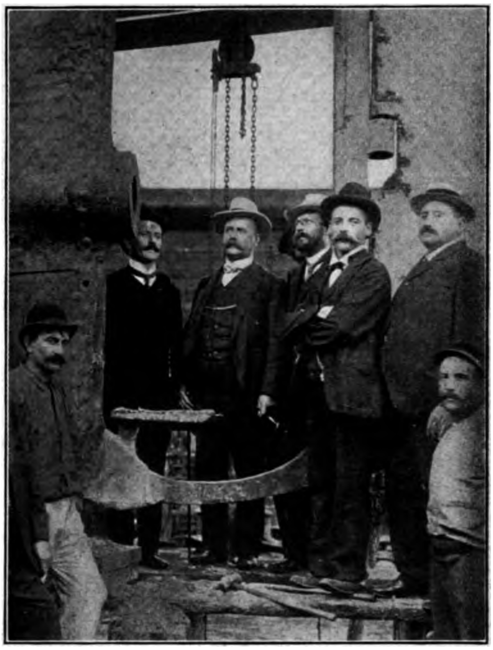
REPAIRING THE STERNPOST OF THE SEBENICO.

The moment of pouring.

grindstones, as a grinding powder, etc.

It is not hard to see the many possible industrial applications for a process which thus permits the production of temperatures so high, in so short a time and with so little apparatus. One of the most important is the welding of iron and steel pipes or tubes, for which all the necessary appliances are seen in the illustration on page 562. The faces to be welded are dressed and fitted to one another, and then pressed together by a suitable device. The joint is then surrounded by a mould which varies in form according as the tubes are large or small in size, vertical or horizontal in position. (Page 563.) Into this mould is poured the incandescent mass produced from the thermite. The heat which it imparts raises the metal of the tubes to the welding temperature. This operation is particularly valuable in the making of bends or coils, in which defects often develop after the bending in completed, and the otherwise finished piece is on that account rejected. The defective part can now be cut out and replaced by a sound section welded in with thermite. The method can be adapted also to the formation of bosses for taps or branches. (Page 566.)

Equally important is the application to the welding of rails, which may be accomplished in shorter time than is required for making a good joint with bolts and fish plates. Page 562 shows the entire necessary outfit. Besides its lower cost, this process has some decided advantages over the bolted-joint construction. In addition to an actual welding of the rails end to end, there is obtained a kind of splint of soft malleable iron forming an integral body with the foot of the rail. The gain in point of better return circuit for the current in the case of electric railways is apparent. Further, it gives a continuous rail, free from jolt-producing joints, and thus ensures longer life both of the rail and rolling stock.

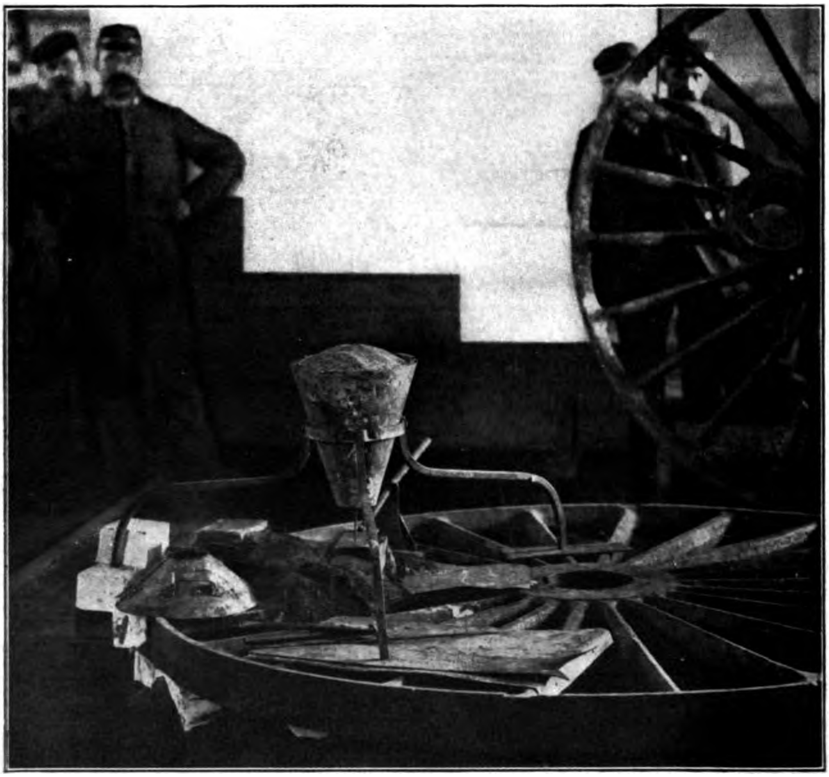


REPAIRING THE STERNPOST OF THE SEBENICO.
The weld completed.

In like manner shafts may be welded; defective, worn, or broken machine parts, whether of cast iron, steel, or wrought iron, may be repaired; bearings of rolls may be welded; gear teeth may be mended or replaced—in fact, welding or casting of steel parts be accomplished anywhere and instantly.

The method is applicable also to intercalary casting. Striking evidence of the intimate union effected is afforded by the examination of an acid-etched section of 140-millimetre bars thus welded. On page 567 are shown castings of thermite iron incorporated with boiler plate of 20 millimetres thickness. The pieces have been cut half through, fractured, and then etched with acid to bring out the weld. Finally, the process permits the welding of cast iron to steel, and

REPAIRS OF WROUGHT-IRON PIPE BENDS, ABOUT 8 INCHES AND 4 INCHES DIAMETER.



REPAIRING LOCOMOTIVE DRIVING WHEEL, AUSTRIAN STATE RAILWAYS.

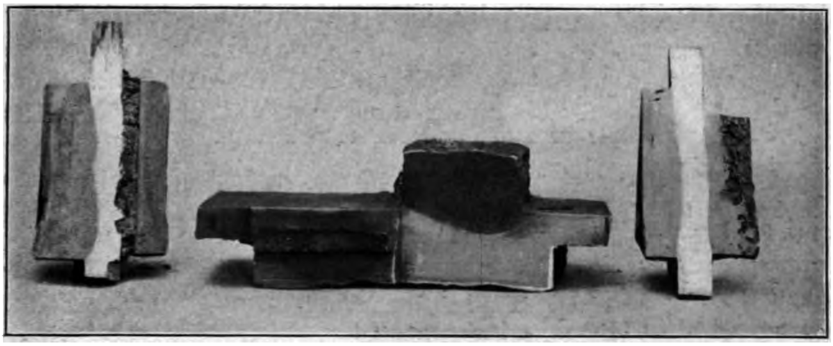
vice versa. And, especially with the so-called "automatic" process, it does not require a highly skilled labour to apply it. One or two workmen are sufficient in the majority of cases.

CONNECTING ROD REPAIRED WITH THERMITE.

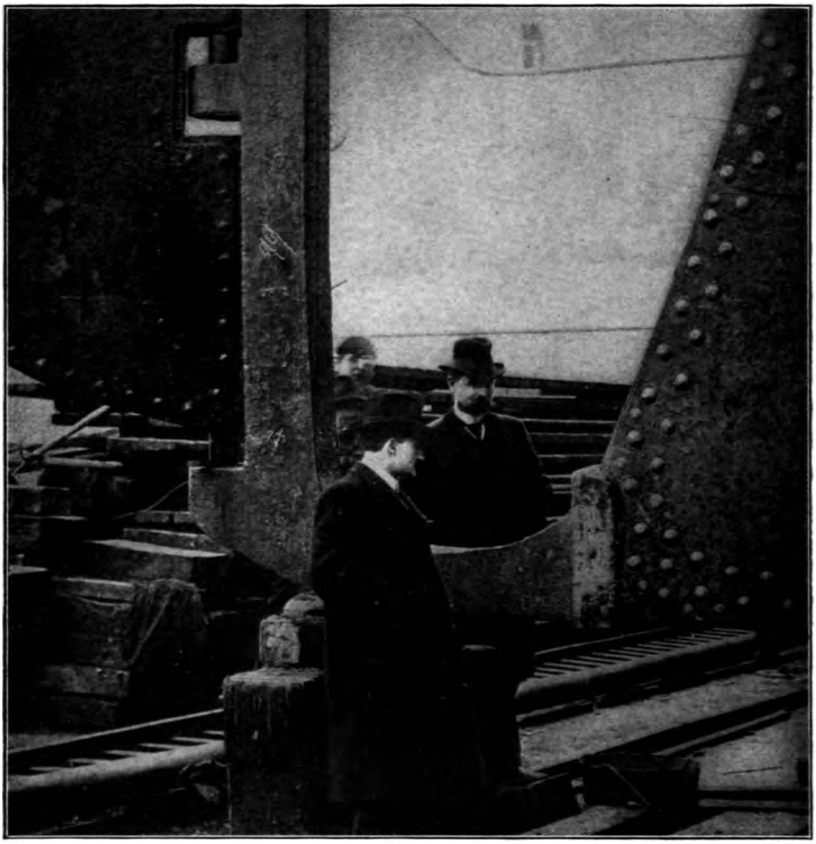
It is needless to list or to dwell upon the many cases to which the exothermic process and reagents may be applied. They will suggest themselves on a moment's thought of the contingencies arising constantly in the workshop, the factory, the steamship—indeed, wherever machinery is used or metallurgical processes are carried on.

The process is not "revolutionary" in the larger sense, but belongs to the order of those discoveries and inventions which, by their commanding convenience of application, greatly increase the ease of mechanical operations, or even enable entirely new operations, and so minister to the economy of manufacture and production and to the progress of engineering industry.

The possibilty of repairing large machine or structural parts, suggested by some of the illustrations in the preceding pages, without dismantling the whole construction or taking the broken piece out of its place, alone implies great savings of time and labour. Thus the fractured crank shaft of a Rhine steamer, although 10 inches in diameter, was repaired between five o'clock in the evening and



ACID-ETCHED SECTIONS OF WELDS OF CAST IRON ON 20-MILLIMETRE BOILER PLATE.



REPAIR OF BROKEN STERNPOST OF STEAMER "SEVILLA," 9,000 TONS, HAMBURG, NOV., 1902.

Section 200 by 500 millimetres. 300 kilogrammes of thermite used.

ten o'clock the next morning. Two and a half hundredweight of thermite were used on the job. The Hamburg-American liner Sevilla, the broken sternpost of which was welded in place as shown on this page, has repeatedly made the voyage between Hamburg and Argentina and is registered full class at Lloyds. The method, in short, carries the repair operations to the break, with the utmost ease of transport and range of adaptation, instead of requiring the broken part to be brought to the repair shop.

CUTTING SPEEDS AND FEEDS WITH THE NEW TOOL STEELS.

By Oberlin Smith.

IN THE ENGINEERING MAGAZINE for April last I considered the subject of the new high-speed cutting tools and their effect on machinery manufacture in general. This was followed by articles in the *American Machinist,* pointing out more particularly the mechanical changes that would have to be made in the machines for doing this cutting with the new-found alacrity incident to the new conditions. The purpose in undertaking this short article was to give some further records of actual high-speed work.

Unfortunately, a recent fire, which entirely destroyed the Machine Works with which I am connected, cut short the line of experimenting that I was following, leaving but one little record as given below. A curious incident connected with this fire happened in the starting up of a certain 62-inch vertical boring mill, after the ruins of the building and its own countershaft, which had fallen upon it, were cleared away. A heavy 40-inch flywheel was in process of being turned the afternoon before the fire, with a high-speed steel tool taking a heavy roughing cut down its face. By what seemed almost a miracle, the machine was injured but little and worked perfectly after starting in motion, neither the wheel nor the tool being unset or altered in position. The turning proceeded as usual, the remainder of the cut being taken from the face of the wheel without disturbing anything. The tool, which must have been very hot, appeared to be in perfect order and both machine and tool have been doing work ever since on similar flywheels, running at a speed of about 50 feet per minute.

The unfinished record of experiments above referred to shows first a new brand of high-priced steel, the vendor of which did not know whether or not he could claim it to be of the high-speed order. This tool ran about four minutes at 28 feet per minute, before the edge was spoiled. The second experiment was with a self-hardening steel sold by vendors of composite tools (those in which the cutter is inserted and held by a set-screw) as of the most suitable quality for their purpose. It ran at a speed of 63 feet per minute for about a minute-and-a-half, when the point gave out entirely. The third experiment was with one of the new high-speed steels, which remained perfectly good after running 117 feet per minute for several minutes. The material worked was a medium-hard steel shaft forging, and the chip was something over 1/16-inch square.

In the absence of recent data of personal work, it may be of interest to here give a compilation of some of the work being done by certain steel-makers and other experimenters who are developing this era-making subject. This will at least give some indication in regard to the present state of the art—the rapidly changing and developing art of metal cutting.

A friend who is eminent in machine-tool design writes that he has found no economy in trying to cut cast iron faster than 50 feet per minute. He says, however, that this limitation may be due to the lack of rigidity in the lathe and in the work being operated upon therein. He remarks further that the reason he has no definite results to report is not because he has not had samples and experience, but because he has not machines that have sufficient strength and speed.

A prominent company making one of the first-class brands of high-speed tool steel reports experiments from some of its customers as follows:—Used a roughing cut on soft steel at 100 to 120 feet per minute, and finishing cut 165 to 200 feet. Turned a cast-iron drum 12 inches diameter by 42 inches long, with a roughing cut at 85 feet per minute, 1/8-inch feed, 3/4-inch depth of cut; ran a finishing cut with the same feed, at 185 feet per minute, the tool remaining in good condition in both cases.

Turned a 68-inch Krupp locomotive tire, feed 1/8-inch, speed 16 feet per minute; the tool ran all across the face of the tire without injury, while a self-hardening tool of best quality gave out after four revolutions. Also bored a medium-hard locomotive tire with feed of 1/8-inch and depth of cut 1/4-inch at 28 feet per minute. Ran a cut across a cast-iron pulley 72 inches wide at 60 feet per minute, and the tool was undamaged.

Another prominent maker speaks of shipping three-and-one-half tons of tool steel to one customer after he had given it a working trial. Experiments with the same steel at one of the leading tool-making shops in the United States showed results as follows:—On 2-inch diameter .30-carbon machinery steel, using a cutting speed of 261 feet per minute, with a feed of 1/10 inch, a depth of 1/10 inch and a travel of 15 inches, the tool came out slightly dull but good for more work. During the last half of this experiment the tool and chips were both red-hot, in a comfortably light room. In another experiment at the same place, with a shaft 1 1/2 inches diameter, of the same steel, the speed was 194 feet per minute with the feed and depth the same, but with a travel of 18 inches. The tool was red-hot the last half of the time, but held a perfect edge, not needing regrinding.

In regard to another very well-known steel which has been sold to many prominent manufacturers, in one case over 20 tons in a lot, the makers speak of speeds as high as 232 feet per minute, with a feed of 1/8 inch and a cut of 1/4 inch depth, the materials being cast-iron. They tell also of 247 feet per minute, with the same feed and cut, on .40-carbon-steel. We are told of twist drills of this last-named steel running at 128 revolutions per minute, drilling about 600 holes in hard steel castings 5/8 inch thick. This was in competition with regular standard twist drills, which could run but 80 revolutions and bore but 5 holes before entirely giving out. Another drill ran at 480 revolutions, drilling holes in annealed high-speed steel, of its own kind, 1 1/2 inches deep in a minute, without showing any wear.

Another record relative to one of the steels previously mentioned, which was tempered in lead or warm oil, shows speeds from 125 to 142 feet per minute on cast-iron, with 1/16-inch feed and 3/16-inch depth of cut. These continued in some cases for 20 minutes and more without damage to the edge of the tool.

It will be noticed that the chief merit so far claimed for the new tools is the attainment of high speeds, and that the work with them has usually been done in lathes, planers etc., where an ordinary forged and rough-ground tool, with one cutting edge, was employed. In many cases it was necessary to heat the edge of the tool almost to the melting point in the process of hardening; the edge thus became rough and rounded off, requiring grinding afterwards. There seemed, therefore, to be limitations which would rule out such fine tools as milling cutters, reamers, taps and dies, etc., because of the spoiling of the numerous accurate and highly finished cutting edges which, upon any one tool, must maintain their exact relation to one another.

Recently, however, many experiments have been made in producing twist drills, cutters, reamers, taps and dies, and this with unexpected success. The composition of the steel and the methods of hardening have been adapted to these special purposes. In this connection there are records, set forth by responsible steel makers, of threading about 20,000 1-inch track bolts without grinding the teeth of the dies, against only 7,500 bolts cut with dies made from regular steel; also of pointing, with high-speed cutters, 5/8-inch car bolts in lots of 22,000, against 4,000 worked with regular steel tools, before sharpening was needed. We hear again of certain cutting tools working 150 pieces per day for 90 days without grinding, against similar cutters of regular tool steel which did but 50 per day, grinding every 6 hours.

Another recent application of the new steels is for punches and dies, where the matter of speed would not seem to be a factor in the case, but where the steel makers claim a great advantage in durability. One record shows the punching of 56,000 holes in ⅜-inch thick metal, against 6,000 with punches made of regular tool steel. We are told of still another case where 1-inch thick hexagon nuts were punched cold at the rate of 40 holes per minute with 29-hours durability, against less than 4-hours life with punches of regular tool steel.

We hear also of punches in pneumatic rivetters heading ⅞-inch rivets continuously for more than seven weeks without repairing. These tools last in some cases thirty times as long as those made from the best quality of carbon steel.

For sufficient reasons no manufacturer's names have been given in connection with the above information.* They are however responsible concerns whose statements there is no reason to doubt. They and others are constantly striving to improve their product, and there are already in the United States half-a-dozen or more makers who are offering in open market high-speed steels of excellent quality and of grades to suit a variety of purposes. The price, moreover, is reasonable, considering the comparative value of such a time saver. In general the figures will run from 50 to 75 cents per pound, with a tendency to become lower. Such prices, of course, amount to a good deal in the aggregate when large sized tools are forged solid in the old-fashioned way. In such case the greater part of the material is, of course, wasted in the heavy shank of the tool where inferior metal would do just as well. It has been feared that composite tools, made in the usual way with iron sockets carrying inserted cutters consisting of short pieces of square bar-steel, say ¼ inch to ¾ inch square, would not work as well as would forged tools, on account of not carrying away the heat so rapidly. In some experiments made by me, however, there seemed to be no difficulty in this respect. The composite tools do good work and cost much less in the long run.

I do not know of any definite experiments which have been made on other metals than iron and steel, as for example on brass, copper, and other soft metals, or upon wood, leather, etc. One vendor of high-speed machinery speaks of 150 to 200 feet per minute for brass, but this, of course, does not seem very attractive after reading about similar speeds for steel and cast iron. It is to be hoped that definite experiments may be made with a variety of other materials, with a view of obtaining very high speeds, and proper records may be published.

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* Further information will be gladly supplied to those interested, either by the author of the article or by the Editors.

It is probable that the speed figures above, given by various steel makers, are somewhat optimistic, although doubtless correctly stated for the particular experiments cited. In looking over some recently published records in the technical newspapers, more conservative figures on the average are found. Some writers state that the speed limits for cast iron are from 45 to 70 feet per minute. It seems certain that this material is very irregular in its behavior, and that its homegeneity and nearly uniform hardness cannot be depended upon.

The speed per minute at which any material can be cut depends a good deal, after all, upon the *size of the chip,* and no experiments can be trusted to show positive results without the conditions regarding feed and depth of cut entering as important factors into the efficiency of the process of rapid cutting. In a very interesting paper recently read before the American Society of Mechanical Engineers by Mr. Carl G. Barth, he describes the variables that enter into the problem of determining the most economical labor. These he enumerates thus:

I. The size and shape of the tools to be used.
II. The use or not of a cooling agent on the tool.
III. The number of tools to be used at the same time.
IV. The length of time the tools are required to stand up to the work (LIFE OF TOOL).
V. The hardness of the material to be turned (CLASS NUMBER).
VI. The diameter of this material or work.
VII. The depth of the cut to be taken.
VIII. The feed to be used.
IX. The cutting speed.
X. The cutting pressure on the tool.
XI. The speed combination to be used to give at the same time the proper cutting speed and the pressure required to take the cut.
XII. The stiffness of the work.

Then he goes on to describe certain ingenious slide rules which have been contrived for determining mechanically the various problems entering into the question of how much solid material can be turned into chips in a given time. Mr. Barth has been an earnest experimenter in supplementing the great work done by Mr. Fred. W. Taylor in reforming shop management and he has systematically manufactured a great many tons of chips.

There have been several other investigators in this line, including of course the earlier work of those persevering missionaries Mr. Taylor and Mr. White, who are the original inventors of the high-speed steels, and who should certainly have the high honor of being the pioneers in this wonderful change which has startled the mechanical world and inaugurated a new era in machine-shop processes—its birth being practically coincident with the dawn of this to-be marvelous Twentieth Century. Much good work has also been done in collaboration, by Mr. Kern Dodge and Mr. Charles Day.

Of the peculiar composition of the various high-speed steels now offered in the market little is known by the general public, and doubtless some of the ingredients, as well as the processes used, are kept entirely secret. In general, the material is known as tungsten steel—in contradistinction to the old-fashioned carbon steels. In one patent upon a certain brand the proportion of tungsten is given as from 15 per cent. to 30 per cent., with from 1 per cent. to 3 per cent. of chromium. It is probable, however, that in many of the mixtures manganese, nickel, silicon, and molybdenum are also factors to a certain extent.

A summing up of this interesting subject will show rapidly changing conditions, owing to the frequent discoveries and improvements that are being made in the manufacture of the steel itself, as well as in the methods of applying and using it. The new metal has qualities which marvelously exceed anything that could have been expected, even as late as two or three years ago. Its greatest handicap, is the lack of proper machine tools as an environment in which to follow its vocation. The machine-tool makers, however, are beginning to awaken to the importance of increasing enormously the weight and strength of their machines, as well as of the adaptation of their moving parts to much higher speeds than before. They are also beginning to realize that there must be a better gradation of speeds than is given by the old cone pulleys and back gearing of our lathes and of our boring, drilling, and milling machines. The new conditions demand not only a greater number of speeds properly graded, but also quick and easy methods of changing from one to the other. Such convenience and rapidity certainly cannot be attained by pulling stiff and greasy belts from one pulley to another. The object is beautifully accomplished, however, by the various new contrivances for electrical control, especially where arranged with one of the so-called multiple-voltage systems. A convenient control, as well as various other requisities in cheap and efficient machine-shop equipment, call loudly for a system of absolutely individual electrical driving, each machine being a unit that can stand any where upon the floor, in any position, and that can be easily moved from place to place. There should be no connections to the building except a few wires, and an absolutely free space overhead for cranes to handle quickly any piece of work to be put into a machine. The machines themselves can then be moved quickly from place to place as the particular working of the shop may from time to time show the necessity for a change of grouping.

EDITORIAL COMMENT

LOOKING over the world of engineering in the spirit of retrospect and forecast suggested by the season, one is tempted to wild fancy—or to anxious question—as to the world of the Twenty-first Century. It is barely a century and a quarter since Watt brought out his steam engine, and the whole of this short time has been crowded with fast-following, bewildering, and wonder-working discoveries. Will progress continue at the same, or even an increasing, rate? Probably not—or rather, probably the progress will be of another kind, and will lie in the perfection, the full application, and the mutual adjustment of the great agencies lately brought into use. It will be progress toward the utmost of economy and the utmost of harmony. The age of discovery will be followed by an "Age of Organization."

When James Watt invented the condensing steam engine in 1769 he revolutionized industry. It would require a monster catalogue to illustrate and describe the many types of steam engines that have been evolved since that epoch-making invention, and no one but a skilled statistician could accurately estimate the number of able-bodied workmen whose labor would be necessary to the wealth-creating, productive work that the steam engine is at present doing daily. Indeed, it would be an expression of a mathematical ratio only—not an interchangeable equivalent. The steam engine manifestly does things no manual power could do—opens possibilities of production and further employment which would remain forever closed to mere manual effort.

Watt's idea wrought the revolution. For every steam engine employed since Watt's time represents a special—an up-to-date—adaptation of the original and revolutionary idea. Newcomen's primitive steam engine for mine pumping had been at work for many years; but following closely upon Watt's invention of that which has become the prime mover of the modern industrial world, came Arkwright with the spinning frame, Cartwright with the power loom, Whitney with the cotton gin, Cort with the puddling furnace and the rolling mill, Fulton with the steamboat, Stephenson with the locomotive, and Maudslay with machine tools. Then Faraday and Gramme opened the way for all modern electrical machinery; Morse proved the practicability of the telegraph; Howe introduced the sewing machine; Bessemer and Siemens made steel making on a large scale immensely profitable; and McCormick, with his reaper and mower, applied the same labor-saving principles to agricultural industry.

* * *

JAMES WATT foresaw, with a clearness of vision which busy men now rarely appreciate, that the steam engine was a labor-saving machine which, though it might first supplant, would soon supplement labor throughout all lines of productive industry and ultimately open boundless wholly new fields for higher-class and better paid labor, to the infinite advantage of both employers and their workmen.

But the engine offered a surplus of power possibilities for which there was but limited employment until Arkwright with his spinning machinery founded the factory system; the power-driven spinning frame, in turn, overwhelmed the industry with more yarn than the hand weavers could use; then came Cartwright with the power loom; and when the textile manufactures, now mechanically operated throughout, demanded more cotton than the hand pickers could supply, Whitney with the cotton gin extended the field of the machine one stage further. The first great step taken, invention fostered invention. And in every case the result was the same—a temporary disturbance, attended with bitter and violent opposition and outbreaks on the part of labor, but ultimately a great and permanent rise in the status and the pay of the workman, and eager work for thousands where one had been employed before.

* * *

AND now, within a very few years, a new factor has entered into the system—the factor of definite co-ordination between the actuating power and the producing machine. Call it shop management—call it works organization—call it production engineering—it is the applied science of so directing, so stimulating, and so rewarding the human intelligence which oversees the power-driven machine that the maximum of output shall be secured for every unit of input.

The idea underlying these methods is closely akin to that which was perhaps more concretely expressed in the epoch-making inventions. It is that the prosperity—the progress—indeed the very preservation—of society demands constant increase not only in the total production of wealth, but in the productive efficiency of each individual, and this is to be gained by *continually freeing* him from labor of a lower order so that he may concentrate upon work of a higher order. Every minute and every movement are to be devoted to the most profitable work of which the man and the machine he guides are capable. The quantity of the product, the quality of the workmanship, and the skill of the workman are constantly rising, because useless movements are avoided, and functions lower than those of which the agent is capable are constantly discarded and referred to the following grade in ascending evolution. It is "labor-saving," so-called, in the truest sense—which is only that all labour is saved for and devoted to profitable and wealth-creating ends, to its own vast advantage in the first and most direct share in the new profit and wealth. In the light of all history, labor-saving machinery and methods (far better call them "effort-saving")—result never in diminishing the opportunities for employment except very locally and transiently; the further result is a rise in the status of, and an incalculable increase in the demand for, labor.

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IT is only in the long and the broad view that the facts and their influences are seen in their true bearings, and length and breadth of view are too often lacking, in workmen—and, alas, in employers. They are too often impatient of any studies or any representations that go beyond the homely elements which they can see, and in which they are accustomed to think—a day's time, a day's pay, the cost of materials, the current wage, the present market, details of mechanical equipment, technical questions of engineering. And yet the most important matter of all is the cultivation of the highest efficiency in the human forces by which the whole machinery of production is operated. "Labor-saving machinery" has made society vitally dependent upon labor as it never was

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THERE is in President Roosevelt's message an expression of the meaning and the relations of the Isthmian Canal which is so strong, so clear, and so adequate, that we are eager to quote it and anxious to impress it broadly and deeply upon the convictions of everyone who is or who may be concerned in the completion of the great waterway. It is a keynote—a watchword—for all, not least for the President himself, in all the steps which must hereafter be taken for the building of the canal. The principles which appear in our own course and our own methods must be no lower than those which (very rightly) we have prescribed for Colombia and Panama. The President says:

> "For 400 years, ever since shortly after the discovery of this hemisphere, the canal across the Isthmus has been planned. For two-score years it has been worked at. When made it is to last for the ages. It is to alter the geography of a continent and the trade routes of the world. * * *
>
> "This great enterprise of building the canal can not be held up to gratify the whims, or out of respect to the governmental impotence, or to the even more sinister and evil political peculiarities, of people who * * * dwell afar off. * *
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> "The possession of a territory fraught with such peculiar capacities as the Isthmus in question carries with it obligations to mankind."

It is vastly reassuring to know that the President himself has set this measure upon the entire enterprise, for no lower ideals, of course, can then control the organization and administration of the work of building the canal. The next and immediate step—the appointment of the permanent commission—is no doubt the most momentous of all. The men selected for those posts will make or mar the success and glory of the undertaking.
And it will no doubt
Roosevelt's strength and
of purpose to see that not

eminent fitness is allowed to be the deciding consideration in selecting the members of the commission.

There will be tremendous pressure from many quarters to secure place for men whose fitness is far from preeminent; the President will be importuned to "gratify the whims of," or to yield respect to, political influence exerted in favor of professional impotence; he may even be threatened by yet "more sinister and evil political peculiarities of people who dwell afar off" from the Isthmus, but very near to the doors of the White House.

May he stand strong and inflexible in the actuating conviction that the "great enterprise of building the canal *can not be held up*" by any of these—that the sacred duty to appoint only men of absolute integrity, high executive capacity, and commanding professional standing and ability, is imposed, as he has so well put it, by "obligations to all mankind!"

* * *

THE relation of civilian to military engineering has always been fairly well defined, but in the United States there has existed a certain overlapping not found in other countries. Thus, both civil and mechanical engineers have been regularly employed by the Government in connection with the work of the army, and some of the most successful details of military work have been due to the labor of these men. Now all this is to be changed; the civilians are to go, and the soldiers are to do it all. This is as it should be, always providing that the soldiers are equal to the emergency.

In principle and in theory this position is undoubtedly correct. The Government maintains an extensive military academy, in which young men are taught at the public expense the art of war, including military engineering, and the fact that it has been found necessary to employ civilians to supplement and aid these men in their work certainly seems to reflect upon their capacity. Nevertheless it has been found necessary to employ outside help, and some of the ablest and most highly esteemed members of the profession have been engaged by the Government upon such work as gun construction, gun carriages, machine design, shop equipment, testing, and similar important matters.

It may well be doubted that men who have had no experience in such work can step in at a moment's notice and take charge of such work as a noted civilian engineer has been doing at Watertown, for instance, and it would seem the part of wisdom to permit the men who are experienced in such difficult and important work to transfer it gradually to those by whom it is to be conducted in the future. It may be the best way to teach a boy to swim by throwing him into the river, but in such a case there is nobody but the boy himself concerned; while in the important work hitherto intrusted to civilian engineers the whole nation is interested, and it seems like a rather costly and even risky experiment to proceed so hastily in the matter as present conditions indicate.

We are wholly in agreement with the principle that all engineering in the army and in the navy should be done by the men who have been trained at the public expense to do just such work, and there is no room for doubt that this should always have been the practice; but suddenly to amputate a most important branch of the service in order to put this theory into complete practice seems hardly the part of wisdom, or even of ordinary prudence. We shall watch the manner in which the soldiers proceed in this emergency, wishing them success with an interested anxiety.

REVIEW OF THE ENGINEERING PRESS.

"THE WORLD IS ITS FIELD"

THE DETERMINATION OF WAGES.

PIECE WORK, PREMIUM PLANS, BONUS SYSTEMS, AND DAY RATES DISCUSSED, COMPARED, AND CRITICISED.

American Society of Mechanical Engineers.

AT the recent convention of the American Society of Mechanical Engineers a most active and interesting discussion was evoked by the presentation of several papers bearing upon the question of the determination of wages, and the importance of the subject is such that it demands extended review. The papers which drew especial attention were those by Mr. Richards, upon piece work, by Mr. Barth upon special slide rules for the ready performance of the computations involved with the use of the Taylor differential piece system, and by Mr. Gantt upon the general question of modifying systems of shop management.

Mr. Richards asked in his paper the question: "Is anything the matter with piece work?" and was most outspoken in his condemnation of wage systems which provided for any division of gain between the workman and the employer. Starting with the assumption of the establishment of a unit which is "the amount or quantity of work which the man should ordinarily be expected to do in a day for the ordinary day's wage," Mr. Richards proceeded to deduce the conclusion that the workman is entitled to a continuance of this full rate for all that he produces over and above the ordinary day's work. In other words, straight piece work follows as a logical conclusion from the assumed premises.

It is not difficult to put an outright fallacy into logical form, and this is what Mr. Richards appears to have done. In his case the fallacy lies in the assumption of *the very* thing which he sets out to prove, namely, that the proper wage for a workman for performing a known quantity of work, is already determined or determinable. In ordinary parlance this is what is called "begging the question." If Mr. Richards's premises are granted his conclusions certainly follow, but since his premises are really what he sets out to prove, he is simply traveling in a circle which lands him nowhere. So far as his paper is concerned, therefore, there is no need for considering it further. We know that there is no definite day's work and no determinate day's wage; these are the very things which some of the most earnest practical investigators have been trying to find out. They have learned that each man has a productive capacity of his own, that no two men are worth the same wage or are capable of doing the same work, and they have devised methods which to a greater or less complete extent act to discover just what each man can do and just how much wages he is entitled to receive. Fortunately there were at the meeting some of the most active and devoted men in the society in this department of work, and the discussions of Mr. Richards's paper by Mr. Taylor, Mr. Gantt, Mr. Emerson, and others, gave it a value and importance which would otherwise have been entirely lacking. It was a noteworthy example of the fact that the real value of a paper may often be found in the discussion which it evokes rather than for anything which it really contains.

In discussing the paper, Mr. Emerson

maintained that piece work is wholly wrong, that everything is the matter with it, and that it is a lazy, haphazard method of shifting responsibility and direction from employer to employee.

Says he:

"The fundamental trouble with piece work, in addition to its lack of justice, is that it makes the workman sell what is not his to sell, namely, output. When Mr. J. J. Hill formulated his famous principle that railroad expenses were by the train mile and receipts by the ton mile, neither his train crews nor himself ever dreamed of putting the pay of the men on a tonnage basis. The engineer who hauls sixty 80,000 lb. cars with a hundred ton engine gets no more than the engineer who obeys orders, standing for hours on a side track. The engineer sells his time, his skill, his intelligence, his obedience, but never output, because that depends on conditions over which he has no control; and it has always been a wonder to me that railroads which manage their train problems should be so backward in their machine shop practices and methods.

"What the employe sells, whether in office or shop, is not his 'output,' but primarily his time and his skill, incidentally his intelligence and his obedience."

After reducing the methods of day work, piece work, premium system, Gantt bonus system, Taylor differential system and some modifications to diagrams, and comparing them, Mr. Emerson proceeded:

"When all conditions are properly under control, I much prefer the Taylor diagram based on time. There is something inspiriting in working out a minimum time, in knowing that it can be made with the regularity that a train makes its fast schedule, in proving it, in stimulating the workman to it; but it is equally discouraging to workman, to expert and to employer to be wrecked in full flight by hard iron from the foundry, by variable speed in the engine, by broken belt on main shaft, by any unforeseen and unforeseeable delay, and in such cases the curve back to day rate prevents much trouble.

"Where, in all these lines and curves, when based on time, is there any support for Mr. Richards's contention that they cannot be effective because, as he claims, they offer a reduced incentive at the precise time when the need of incentive is most urgent? Exactly the contrary is true. They all of them offer, just as piece work does, ever increasing pay, which, if pushed to the theoretical limit, would reduce costs to almost nothing, and give the employe an infinitely large sum per day."

Mr. Gantt, in his paper examined the manner in which the Taylor system and his own daily balance method were viewed by practical men, and showed that but few people have grasped the proposed system as a whole, considering it rather as a series of isolated propositions which will do as well if not better when separated than when taken together as a whole. As a matter of fact, the method of Mr. Taylor, in reducing all work to unit times for elementary operations is an essential for accuracy in fixing piece-times for any pieces. When to this is added functional foremanship, with a daily balance, showing that the allotted portion of a job has been done each day, the subject is removed from the realm of empiricism and guess work and brought into the field of rational study and conduct. Each man can then be rewarded according to his value, and every man is provided with the means of making himself as valuable as his faculties will permit.

Some features of the discussion brought out the difficulty which men otherwise most intelligent, have in grasping the fundamental principle which Mr. Taylor has done so much to apply and expound. The ingenious features of the differential-piece-rate system have, in many cases, caused men to overlook what Mr. Taylor calls accurate scientific time study. Instead of attempting to fix a time for a new job by comparing former records and using these in connection with the foreman's judgment, Mr. Taylor established the method of timing the various elements, such as turning, planing, shaping, milling, etc, so that, with the available appliances the time required for a unit amount of any one of these elementary operations was accurately determined. Any new job could then be examined and the required amount of each of these operations taken and multiplied by its unit time, the result giving the proper time to be fixed for the completion of this new job. Under this system there is no difficulty in fixing accuately the time required for any sort of a ob, new or old, and in practice the system as been found to work perfectly well. Mr. Barth has carried this study of unit times still further, and has produced curves which show just what the interrelation of certain of the times may be, so that the speed required to remove a given quantity of metal in a given time may not only be determined, but the result for any other speed or time be computed. In like manner the relation of the life of a tool to its output, or the extent to which it can be pushed and yet hold out until the cut is finished; these, and similar shop problems have all been made the subject of study and scientific determination. In the light of such earnest scientific treatment of labor and its products, Mr. Richards's elementary paper sinks into insignificance, but it can at least be commended in that it brought out such a discussion from such men.

THE DEVELOPMENT OF SHIPBUILDING IN GREAT BRITAIN.

ABSTRACT OF THE PRESIDENTIAL ADDRESS OF SIR WILLIAM HENRY WHITE.

Institution of Civil Engineers.

IT is a growing practice for the presidential addresses before professional societies to embody a review of the especial branch of work to which the speaker has devoted his energies and in which he has attained eminence, and the custom is greatly to be commended. Instead of dreary platitudes, or vague generalties, we are receiving what are practically special monographs from eminent experts and the results form most worthy contributions to technical literature.

In the recent presidential address of Sir W. H. White, before the Institution of Civil Engineers, this idea is admirably carried out, so that we have, in the words of one of the foremost specialists in naval architecture, a resumé of the work to which his professional life has been devoted. The length of the address, and the limitations of space prevent more than a reference to the salient points, but the entire paper forms a most notable contribution to the *Proceedings* of the Institution.

Sir W. H. White's connection with shipbuilding began in 1859, when the highest achievements of the naval architect and the marine engineer were wooden three-deckers with screw propulsion. The Victoria, cited as a leading example of this class, was of 7,000 tons displacement, with but 4,200 horse power, making a speed of about 12½ knots. With this she had a full sailing equipment, while her armament consisted of smooth bore guns on wooden carriages, the heaviest being an eight-inch 68-pounder, firing spherical cast-iron projectiles.

Since 1859 nearly all the changes which have made modern marine engineering and construction what it is have taken place, and these changes Sir W. H. White has summed up as follows:

"In 1859 the highest steam pressures used in marine boilers were from 20 lbs. to 25 lbs. per sq. in.; twenty years later 90 lbs. to 100 lbs. had been reached, and the 'compound'—double-expansion—type of engine was in general use. Now in the mercantile marine, with the ordinary—water-tank cylindrical—boilers, pressures of 210 lbs. to 220 lbs. are common, and a little less than 270 lbs. has been reached in a few cases. For warships, with water-tube boilers, pressures of 250 lbs. to 300 lbs. have been used for nine years; but in the most recent vessels, in which 20 per cent. of the total power is in cylindrical boilers, with the balance in water-tube boilers, the pressure adopted is only 210 lbs. With these high pressures triple or quadruple-expansion engines are associated.

"There is a widespread feeling amongst marine engineers that, with cylindrical, or 'tank' boilers, it is not desirable to exceed 220 lbs. per sq. in. as the steam pressure; and, although quadruple-expansion engines are favored for the highest pressures used in the mercantile marine, triple-expansion engines are made in much larger numbers. For ships of the Royal Navy triple-expansion engines of the four-cylinder type are used, with two low-pressure cylinders and four cranks; and this is the arrangement adopted in many large-powered merchant steamships. With higher steam pressures than 220 lbs., certain difficulties occur in the pipe joints and other parts liable to leakage of steam.

"This rise in pressure and greater expansion have been accomplished by an increased rate of revolution and piston speed. In 1859 for the best types of engines in screw steamers the revolutions did not exceed 50, and the maximum piston speeds were about 400 ft. per minute. In 1881 the averages for merchant steamers were about 60 revolutions, with 470 ft. per minute piston speed; now the corresponding averages are nearly 90 revolutions, and over 650 ft., while many steamers of high speed attain piston speeds of 900 ft. to 1,000 ft. The "Deutschland," at first, is reported to have worked at about 75 revolutions with over 900 ft. piston speed; on her later service the revolutions have risen to over 80 per minute with 1,000 ft. piston speed when developing about 36,000 H. P. with twin-screw engines. In warships the rates of revolution are higher and strokes shorter than in merchant ships. In 1881 the revolutions for battleships were about 80, and the piston speeds about 650 ft. to 700 ft. per minute. Now they have been increased to 100 or 110 revolutions, with 850 ft. to 900 ft. piston speed. For swift cruisers of large power, 120 to 140 revolutions and 1,000 ft. of piston speed are now common; smaller cruisers have about 220 revolutions with equal piston speed; destroyers have 350 to 400 revolutions and 1,100 ft. to 1,200 ft. piston speeds."

In connection with the modifications enumerated may be mentioned the change from horizontal to vertical engines, the introduction of water-tube boilers for cylindrical boilers, as these latter themselves had superseded the box flue boilers of earlier dates and lower pressures.

"Remarkable economies of weight in proportion to power developed have accompanied these changes. Taking the contractors' trials for the specified maximum power, it is found that each ton weight of propelling apparatus, in full working order, gave about 6 I. H. P. in 1859: whereas in present practice about 9 I. H. P. is obtained in battleships with cylindrical boilers, and about 10.5 I. H. P. with water-tube boilers. In large cruisers with water-tube boilers, such as the "Drake" class, about 12 H. P. per ton is obtained; in third-class cruisers with water-tube boilers, having thinner and smaller tubes, about 20 H. P.; and in destroyers from 40 H. P. to 50 H. P. The large cruisers have proved themselves capable of developing about 75 per cent. of their maximum power for continuous steaming at sea, which corresponds to 9 H. P. per ton; for the small cruisers and destroyers 50 per cent. to 60 per cent. of the maximum power can be maintained as long as the coal lasts; taking 50 per cent., this gives 10 H. P. per ton weight for the cruisers, and over 20 H. P. per ton for the destroyers."

In regard to the question of submarine boats, Sir William White has but little information to make public, although he admits that the Admiralty is giving the subject serious consideration. While maintaining that the problems concerning this class of vessels have been long studied and well understood, he admits that others have obtained the greatest practical experience in this work. Such work as the Admiralty has undertaken has been placed in the hands of the firm which has acquired the rights of Mr. John P. Holland, and Sir W. H. White says: "In the development of details, upon which success largely depends, experience is of the highest importance. Mr. Holland has unrivalled personal experience and great mechanical skill. Consequently, my advice to the Admiralty was to avail ourselves of the opportunity to secure that experience, and by concentrating orders in the hands of an eminent firm many advantages are gained, while secrecy is maintained."

The advantages obtained by use of the experience of Mr. Holland will be admitted, but the ability to maintain secrecy while similar boats are being built elsewhere remains to be seen. In any case there is every reason to believe that it is upon superiority in just such craft that coast defense in the near future will depend, while possibly the whole system of naval attack and defense will be revolutionized.

That sea power is most essential to all nations which possess a coast line is now admitted, while for an island kingdom, necessarily drawing its food supplies from abroad, as is the case with Great Britain,

ral supremacy is necessary for its exist-
ce. "This is no new doctrine; it was
ll understood and acted upon centuries
o. At times it may have been obscured,
there may have been neglect of adequate
asures to insure supremacy, and a care-
s confidence that we could live upon the
putation of the past. No such mood now
ssesses the nation. The events of the
st fifteen years prove that, at all costs,
ere is a resolve to maintain our position
the greatest naval power. Not as a
enace to other nations, but as a guarantee
f peace on the high seas, the free flow of
mmerce throughout the world, and the
ninterrupted communication between the
idely-scattered parts of our great empire.
he navy—meaning the mercantile as well
s the war fleet—is the essential bond of
nion between the mother country, the col-
nies, and possessions beyond the seas—
he common assent of all. No better routes
than the ocean offers can be found for the peaceful intercourse between us and our brethren, which is the great object of our aspirations, and our established policy is to hold these ocean highways open to all nations, claiming no monopoly or exclusive rights. Our war-fleets are the guardians, our merchant ships the messengers of peace. As was well said by the three Admirals in 1888: 'No other nation has any such interest in the maintenance of an undoubted superiority at sea as has England, whose seaboard is her frontier. England ranks among the great powers of the world by virtue of the naval position she has acquired in the past, and which has never been seriously challenged since the close of the last great war. The defeat of her navy means to her the loss of India and her colonies, and of her place among the nations.' Such a disaster can never happen so long as our national spirit is maintained."

WORKSHOP ECONOMICS.

THE IMPORTANCE OF ACCURATE COST-KEEPING METHODS TO THE ENGINEER AND MANUFACTURER.

American Academy of Political and Social Science.

ALTHOUGH bookkeeping as an exact science has long since been one of the essentials to commercial affairs it is only within the past decade that it has been seriously considered at length in connection with manufacturing. Attempts at shop records and cost-keeping have been made, it is true, but they have been regarded askance as themselves costing more than the information which they yielded.

Of late, however, the introduction of cost-keeping systems has made rapid development, and there is no longer any question as to the value of such records and methods to the proprietors of manufacturing establishments. For this reason a paper by Mr. Conrad N. Lauer in a recent issue of the *Annals of the American Academy of Political and Social Science* upon the importance of cost-keeping to the manufacturer is of interest and value, especially in that it brings the broad principles of modern methods to the attention of the general and non-technical reader.

"In order that the manufacturer may secure maximum production at a minimum expense, it is absolutely essential for him to know what his product is costing him. Not only is it essential to know the gross *cost*, but he must also know the cost at each stage of production. The three important divisions of the cost of any manufactured article are: Labor, material and general expense. The simple record of time and wages, in the pay-roll book, might appear to be sufficient as far as labor is concerned. If the subject be carefully analyzed, however, two very important subdivisions of labor will be found, namely: productive and non-productive. Productive labor is the labor expended in actually producing something. Non-productive labor is the labor which is not directly chargeable to some specific factory or production order. Each of the above elements of labor can be analyzed into other elements of importance.

"To a person unfamiliar with the subject, a cost sheet might be looked upon as something valuable merely as a means of determining or fixing a selling price for a given product. While this is, of course, one of its functions, the general information it places in the hands of the manager is of no less importance. In the analysis of time and wages the cost account should so record all the factory expenditures as to enable the manager to be always ready to place his finger upon any unusual, or seemingly exorbitant, item of cost or expense."

So far as selling price is concerned, this is rarely determined, except in a secondary degree, by the determination of manufacturing cost. Far more frequently the selling price must meet market conditions, being governed by questions of supply and demand, and by all the disturbing influences of competition. An accurate knowledge of manufacturing costs is here all the more important, since it permits the owner to know how low he may safely sell without incurring loss, while his less accurately informed competitor may underbid the market in ignorance of his mistake. Selling must always be considered as distinct from manufacturing, but the selling department of a business should know positively the limits within which prices may be made.

The details of cost-keeping, into which Mr. Lauer goes to some extent, cannot be discussed in the limited space here available, and many of the most efficient and widely-used methods have already been fully described in the pages of this Magazine. Card-index methods, continuous records of work in progress, daily assembling or records, and especially daily allotment of tasks, with comparison of the extent to which they have been fulfilled; these form the elements of any system, the application and combination of the elements necessarily varying according to the local circumstances and conditions.

Mr. Lauer examines the question of the distribution of general expense, and advocates the method dividing this so that each article manufactured shall bear its due proportion. The older system of making this proportion a percentage of the wage charge on the article is shown to be incorrect, and the combination of an hourly rate for each machine in the shop, plus a percentage to cover that expense which is not directly chargeable to the machines, is recommended.

"This has been called 'The age of intensified production,' and this is surely true, for, *no matter where* you go, you will find manufacturers making heroic efforts to keep up with the tremendous pace set by some more energetic and systematic competitor. This being true, it is evident that he must, of necessity, keep a very close track of all the small details of his business.

"A few years ago a machinist would be fined for wearing out a tool. To-day the wise manager pays the man a premium for wearing it out—with the proviso, of course, that he accomplishes the work that the tool is capable of performing. Take, for instance, a lot of small sprocket wheels which have to be drilled. By careful analysis it is found that it will pay to run drills so fast that each drill press will completely use up one drill in a day of nine hours, in spite of the fact that twice as many holes could have been drilled by each drill used at two-thirds this speed. This could not have been determined except by a correct system of cost accounting.

"A few years ago the machine-shop manager paid seven cents per pound for his tool steel, and nursed both machine and tool. To-day he pays seventy cents per pound for tool steel, and drives both to the limit of their endurance. It would not be possible to determine such a great problem of shop economics by any loose system of accounting. He must know exactly what all this extra expenditure of money and energy is bringing him in return, in order to ascertain whether he is being repaid for his trouble and expense."

The question of the management of men and the methods of payment naturally comes up for discussion, but this phase of the subject has already been reviewed at length elsewhere in this issue. The relation of this department to the cost-keeping, however, is a matter for especial consideration.

"In an establishment paying its employees by any of the various piece-work plans, it is to the cost department that the manager will turn for information upon which to base his rates. In many establishments operating under a piece-work system, the cost-keeper is the man who fixes the rates. In all well-regulated plants he is the person who records all such transactions with the men, and sees to it that the workman receives his pay when the contract is completed. He not only records piece-work ind wages, but has direct supervision time-keeping and payment of wages. :. Frederic W. Taylor, the pioneer and ost inventor of advanced systems of management, has, in his plan of func-foremanship, considered the cost-r of such importance that he has made ne of his functional foremen. He has him direct charge of the men, and them directly responsible for all mat-ertaining to time and cost. This leads other line of thought. If a manufac-decides to install a system of cost and y accounting, and places a man in : of the same, the cost-keeper will pro-o collect data and information, but he e unable to make this data of any real unless he is given the proper amount hority to apply the facts so ascertained. ie can ever accomplish any real good is compelled to apologize to some one, at every turn, for having exceeded his authority. He must, of course, have respect for vested authority wherever he finds it, but he must also have sufficient authority vested in him to enable him to accomplish the desired end. If this is not the case, he would be very much in the position of a jockey who might be placed astride of a race horse and told to win the race, but on no account to use whip or spur. His only means would be gentle persuasion, and when the pace became hot he would fall behind, finish in the rear, or, perhaps, be distanced altogether.

"To sum up all this, the cost-accounting department must record all information relative to time and material, so as to be a means toward the end of reducing costs and expenses, and then, after such records are made, to assist in their application toward that end."

THE EDISON STORAGE BATTERY.

ECORD OF PRACTICAL EXPERIENCE WITH THE ALKALINE ACCUMULATOR IN ELECTRICALLY PROPELLED VEHICLES.

Institution of Electrical Engineers.

LTHOUGH the storage battery has found numerous practical applications, both for equalising the load generating stations and for the supply rrent for electric vehicles, it has ous disadvantages, which engineers ectricians have long sought to remedy. of the most promising improvements line of work is the alkaline battery, ich the type designed by Mr. Edison l years ago has attracted the most on.

paper recently presented before the ition of Electrical Engineers by Mr. ibbert some interesting practical in-tion is given concerning tests made n automobile equipped with an Edi-ttery, and as this is the most com-account of the apparatus which has nade public since the original paper . Kennelly several years ago the mat-mands attention and review.

principal advantages claimed for the e battery are lightness, strength, and lity. These features are secured by e of plates of sheet steel, carrying s of active material, and an electrolyte which is not decomposed, permitting the use of a sealed cell. Mr. Edison's characteristic criticism of the lead storage battery: "The darned thing is wet!" also applies to his own battery, but at least he has dispensed with the acid, and has enabled the containing cell to be closed against spilling.

In the standard automobile cell of the Edison type, such as was tested by Mr. Hibbert, there are 14 positive and 14 negative plates, each plate being made of sheet steel, nickel plated, and punched with 24 rectangular holes. In these holes are placed perforated pockets containing the active material, this material being nickel peroxide for the positive plates and finely divided iron for the negative plates, the materials in each case being mixed with flake graphite.

The liquid is a 20 per cent. solution of potash, and the whole cell is sealed in a steel case, provided with a stopper opening for adding water, and a vent hole guarded by a gravity valve to permit the escape of the gas evolved during the charge. The outside dimensions of the cell are 13 inches high, by 5.1 by 3.5 inches base, the whole weighing 17.8 pounds.

The most important question about the battery is supposed to be its relative weight. Mr. Hibbert gives the output as 210 watt-hours, which for a weight of 17.8 pounds gives 11.8 watt-hours per pound of cell. While figures nearly as high as this have been obtained with other cells it has been done only with considerable risk, and in the Edison battery it is the normal proportion. The weight of lead cells can be reduced only by making the supports very thin, increasing the fragility and shortening the life.

The influence of temperature on output is an important feature with the lead cells, but such experiments as have been made tend to show that even a marked rise in temperature produces but a small effect with the alkaline accumulator, much less than is the case with lead batteries. In the latter case a rise in temperature causes an increase in the rate of diffusion of acid, and the more rapid circulation causes a corresponding increase in activity. With the alkaline cell there is no need for circulation or diffusion of the liquid, and the only effect of an increase in temperature is a reduction in the internal resistance of the cell.

Mr. Hibbert gives a number of curves showing the behaviour of the cell under different conditions of charge and discharge, and these show conclusively that it can maintain a high rate of discharge. In testing to ascertain the maximum charging rate a cell was carefully discharged at 30 amperes, down to 0.75 volt. It was then charged for one hour, 177 ampere-hours being put in. The current was not quite steady, varying from 180 to 176 amperes. The subsequent discharge showed that 124 ampere hours were delivered, or about 70 per cent. of the charge. Experiments with motor car work show that the cell can be charged at over 200 amperes, and the maximum rate does yet appear to have been reached. Experiments with discharges varying between 60 and 230 amperes give a very interesting pressure curve, showing that the cell behaves like an elastic structure, its pressure rising and falling with the varying demand, but responding at such a rapid rate that the lines of changing pressure appear vertical.

The most interesting portions of Mr. *Hibbert's paper,* however, are those relating *to his practical* experience with the Edison battery in operating an automobile. A Studebaker runabout was fitted with 38 Edison cells, the whole outfit, including two passengers having a weight of 1,950 pounds. 700 pounds of which were due to battery. Although the motor was a 40-volt, 24-ampere machine, the battery gave an average pressure of 48 volts, so that the conditions for successful working were not the most favorable. With this outfit a speed of 14 miles an hour on a level was obtained, the power being about 1,920 watts, corresponding to 2,200 watts per ton, and giving a tractive effort of 79 pounds per ton. Allowing 85 per cent. for motor efficiency the tractive effort is 67 pounds per ton.

The work appears to be about 135-watt-hours per ton-mile, a higher figure than has been obtained elsewhere, but not unexpected, considering the want of balance between the battery and the motor.

A diary of road and general service of this vehicle, in France and in England, shows an excellent record, runs of 30 to 40 miles on one charge being given, with much irregular service, there being a total of 508 miles, which, added to 400 miles run before Mr. Hiblert took control, gives 908 miles. Tests made in connection with these road trials practically confirmed the previous laboratory investigations. A 40-mile run in England, occupying 3½ hours, gave 150 ampere-hours, while the laboratory tests at the same rate showed 159 ampere-hours. Observations of varying rates of discharge showed that with 50 to 60 amperes on a level the rate rose to 90 to 100 on slopes, and in one instance was over 150 amperes. Results of rapid charging are also interesting. In one instance, owing to local conditions it was necessary to charge rapidly, 150 ampere-hours being received in one hour, and in the subsequent run 107 ampere-hours were delivered, an efficiency of 71 per cent. Again, after having been allowed to stand discharged for ten days, the battery received 186 ampere-hours in one hour, and the subsequent discharge, during a 31 mile run about London yielded 134 ampere-hours, or 72 per cent. of the charge.

So far as the important question of durability and permanency is concerned, the experience seems hardly extended enough to enable full information to be secured, but the battery showed no appreciable deteriotion during the experience which Mr. Hibbert had with it, although the conditions were such as to give this feature a reasonable test. Mr. Hibbert says, concerning the connections: "My 500 miles on the road were sufficient to test them, and not one of them failed or became weak. Not one of the terminals had to be touched from the beginning to the end of the run. We had rough roads and rough weather, so that the motor was seriously overloaded, and the car was so strained that it had to go into serious repair as soon as our run was finished, but the battery and its terminals endured it all."

THE GENERATION OF SUPERHEATED STEAM.

DATA AND RESULTS OF EXPERIMENTAL INVESTIGATIONS OF PRACTICAL STEAM-SUPERHEATING APPLIANCES.

Dr. Otto Berner—Verein Deutscher Ingenieure.

FOR a long time the advantages of using superheated steam in engines have been understood and appreciated, and many years ago a variety of superheaters were designed and put in operation. In fact, the disastrous explosion which occurred on the steamship Great Eastern on her trial trip consisted in the bursting of a tube of the superheater which was fitted in the uptake, and was the cause of the death of several persons. The lapse of time which appears in the practical application of the well-known advantages of superheating may well be attributed to the constructive difficulties which have been encountered, both in the superheating apparatus and in the engines in which the high-temperature steam is to be used.

At the present time, however, the improvements in metallic packings and in lubrication, as well as the introduction of the steam turbine, have called attention once more to superheating, and it is realized that there is probably no more available direction for the improvement of the efficiency of steam motors than in the line of superheated steam.

Under these circumstances the paper of Dr. Otto Berner, published in recent issues of the *Zeitschrift des Vereines Deutscher Ingenieure,* discussing the present appliances for generating superheated steam, is especially worthy of attention.

After a brief examination of the thermodynamics of superheated steam, Dr. Berner proceeds to examine the materials of which the superheater may be constructed. The range of choice is not great, the materials available being either a cast metal, cast iron in practice, or wrought metal in the form of tubes of wrought iron or steel. Although cast iron was largely employed in the construction of the early superheaters there is present but one design in extensive operation in which this material is used, the well-known Schwörer superheater. Many installations of this apparatus have been made during the past ten years, and the durability and reliability of cast iron for the service has been fully established. Dr. Berner gives the records of a number of these superheaters, showing their performance to be excellent. In the great majority of designs, however, tubes of wrought iron or steel are employed, and the extent to which these materials meet the requirements is examined.

Apart from the actual resistance to the pressure of the steam, the principal property demanded of the material is durability. Superheaters are exposed to corrosive action from the steam within and from the furnace gases without.

The corrosion or pitting of the interior of superheaters has not been given especial study. It has been attributed to the action of free oxygen, liberated by the dissociation of the steam, and although the temperature of the separation of the oxygen and hydrogen is given as from 1,000 to 2,500 degrees centigrade, there is reason to believe that it commences at a much lower temperature, so that it is possible that oxidation may result from this cause. The limited observations which have thus far been made do not indicate any difference in the extent of this action upon cast or wrought iron. So far as external corrosion is concerned, the extent of the action appears to depend upon the temperature. For temperatures of
to 300 degrees centigrade no appreciable
ference appears between cast and wro

iron, and for higher temperatures data are lacking. The fact that cast-iron superheaters are made to such a limited extent practically dismisses them from extended consideration in the investigations upon which Dr. Berner makes his report, and leads us to consider the elements upon which the design of tubular superheaters depends.

The rate of transmission of heat to the steam is a question of importance, and this appears to depend to a material extent on the arrangement of the parts. Tests made with the flow of hot gases in the same direction as the flow of the steam in the tubes gave lower results than when the flow of gases took place in the opposite direction, the hottest gases meeting the hottest steam. By using the latter arrangement the efficiency is shown to be nearly 19 per cent higher than with the former, a result which is in agreement with the views of Rankine as regards the action of heat in steam boilers.

The performance of a superheater depends upon several elements, and the tabulated results of tests of various cases enable interesting conclusions to be drawn. The percentage of moisture in the steam delivered to the superheater affects its work very materially since a portion of the heat delivered to the superheater is expended in evaporating this moisture. The idea of using a superheater to enable a priming boiler to deliver dry steam is not to be commended, and it is desirable, if the best efficiency is to be secured, that the boiler be so designed as to deliver saturated, but not moist steam to the superheater. The rate of heat transmission to the superheater varied greatly with different kinds of boilers, this evidently being due to the rate of flow of the gases over the superheating surface. According to the experiments examined by Dr. Berner, the coefficient of heat transmission, that is, the number of heat units transmitted per square metre of superheater surface per hour, varies greatly for boilers of different kinds, owing to the differences in the velocity of the gases. The velocity of the steam must also be taken into account, and when the superheater tubes have a small area, giving to the steam a correspondingly high velocity, the value of the coefficient was found to be materially reduced. The actual results of the experiments of a local section of the Verein Deutscher Ingenieure are fully tabulated by Dr. Berner, and these show that before any extensive installation is to be made the value of the coefficient should be determined for the actual conditions under consideration.

In general conditions the highest results are obtained by using independently fired superheaters, and although these involve the combustion of additional fuel they may in many instances be found more economical in the long run. When the grate and heating surface of the boilers are properly proportioned to each other the temperature of the discharge gases should be too low to enable them to be employed to advantage in superheating the steam. The superheater should not be installed to make up for deficiencies in boiler design, but should stand on its own merits as a separate auxiliary apparatus.

Various devices have been made to effect a thorough transfer of the heat to the steam. In the Schwörer superheater, already referred to, the cast-iron tubular sections, of comparatively large size, about 7 inches inside diameter, are made with extended surface in the form of circumferential ribs or fins on the outside, and longitudinal ribs, somewhat like those of the Serve boiler tube, on the inside, this arrangement retarding the flow of gases and steam and affording increased heating surface. Another type of superheater is made with spiral partitions inside of the tubes, thus causing the stream of steam to rotate and come into contact with all parts of the heating surface. There is no doubt that such devices increase the coefficient of heat transfer, and thus enable a smaller superheater to be used than would otherwise be practicable.

While the experiments upon which Dr. Berner's paper is based cover but a period and practice the manner in which the data are tabulated render his paper a valuable one, especially in view of the lack of reliable information upon this important subject. Too often the discussions upon superheated steam deal entirely with the use of the steam after superheating has been accomplished, leaving out of consideration the important questions connected with the design of the apparatus necessary for its production.

THE MONEY VALUE OF TECHNICAL TRAINING.

MPARISON OF THE INDUSTRIAL EARNING CAPACITY OBTAINED FROM VARIOUS DEGREES OF SCIENTIFIC KNOWLEDGE.

American Society of Mechanical Engineers.

HILE there many things of which the true value cannot be measured in money, yet the use of monetary often enables comparative statements lue to be made in a manner which ap- to the general reader in a very effect- anner. Taking this basis for his argu- Mr. James M. Dodge, the retiring lent of the American Society of Me- al Engineers, took up in his president- dress the question of the money value fferent degrees of technical training, g in a diagram the potential values of n various lines according to the cap- which their respective earning powers e interest. As to the correctness of ew which assumes that a man can be apitalized, there may be several opin- and if this principle is no sounder for han it has shown itself to be for cer- industrial enterprises, there may be ment of uncertainty in the deductions, a comparative method it may be ac- l, in lieu of any better basis.

Dodge divides his material into four s; the first representing untrained the second the shop-trained men, the those who have had the advantages of school instruction, and finally the ates of the technical schools. The m shows at once that the force of any rison depends upon the stage in the of the man at which the comparison le. The men having the lower degrees ool training begin to earn money soon- n those who invest that portion of time in study, but as time goes on nclinations of the curves change. the line representing the unskilled assumes the horizontal position, and years go on it rises no higher, there no basis for further development.

trade-school man, on the contrary, up at a rapid pace, but he too begins ken off, and gradually approaches a m rate, although naturally much high- n that of the unskilled man, while the rained group occupies a place about y between the two. All these curves have the same general characteristics, being practically concave to the base at all times, and thus possessing a difference in degree only.

The curve representing the technical school group, on the contrary, is of a different kind, being convex to the base for nearly its entire length, the rate continually increasing until nearly the maximum is reached, when it too, like the others begins a reverse curvature, but not approaching nearly to a horizontal within the limits of the diagram, which extends to the age of 32 years, the average weekly income of the technically-trained man at that period being given as $43.

Although the number of examples from which these data are derived seems hardly large enough to permit any very sweeping generalizations to be made, there is little doubt that they indicate broadly the tendencies of the times.

The distribution of workers in the different grades of occupation naturally depends upon various conditions.

"It is quite obvious that all workers in the mechanic arts cannot be technical graduates. Some must, through natural limitations, or lack of opportunity, follow the apprentice line, and others the trade school. It is from graduates of the latter that leading shop men and foremen are largely selected. These two classes, supplemented by the technical graduate, constitute the vast army of workers in the mechanic arts.

"Thus we see clearly that preparation pays, and that it pays in dollars and cents, and that even a long term of years spent in proper study and technical training is a good investment from every point of view.

"Of course, apprentices have made and will make, in rare instances, a better showing than the average technical man of the chart, and many of our greatest men have, by sheer force of character, excellence of brain fibre, persistence and self-education, risen to preëminent positions, independent of all regular systems. To the end of time great examples of this kind will be found.

Among those whose names readily come to mind are the elder Krupp, Joseph Whitworth, George M. Pullman, Andrew Carnegie, John Fritz, Prof. John E. Sweet, Edwin Reynolds, George H. Babcock and Coleman Sellers.

"The same is true of the trades school graduate, but as said before, we are dealing with the average of each class, taken from actual statistics, with an earnest desire to ascertain the facts, and without any preconceived notion of the outcome."

An important feature in connection with the value of labor is brought out by Mr. Dodge, when he states that it is a truism that every man pays for the amount of bossing he requires, and that every man's wages increase in proportion to his ability to act as a boss or foreman of himself or others. One of the great advantages to the employer of high-value labor is the fact that the cost of superintendence is greatly diminished, while the ability of a man to manage himself is the greatest of all capacities, reached to the highest degree only in those eminent instances of the heads of successful enterprises.

"The highest wages are paid to the man through whose ability the largest number of other men may be most profitably employed. He does his work with his brain. Thus, on the one hand, we see manual labor receiving no wages, and on the other mental labor reaping the highest reward. Between these two extremes is found every condition of human life.

"A practical man performs his work within the radius of his arm, a technical man within the radius of his brain. This fact is, even to-day, realized by the few, but it is gratifying to know that the number is increasing.

"The technical training of an individual makes him valuable just in proportion as his ability is manifested by good judgment and perception. Trained common sense receives the highest compensation and reaps the greatest reward.

"Mental ability to receive ideas and impart them properly and wisely, rearranged and grouped, is typical of the most brilliant mentality; a dull intellect may be compared to blotting paper, fit only to absorb and inter a heterogeneous mass of impressions."

THE DEFORMATION OF MATERIALS.

A STUDY OF THE MANNER IN WHICH EXTERNAL STRESSES ACT TO PRODUCE INTERNAL STRAINS IN METALS.

H. Bouasse—Société d'Encouragement pour l'Industrie Nationale.

AMONG the advances which have been made in the applied science of engineering one of the most interesting is the progress which appears in the treatment of the strength of the materials of construction. Formerly it was considered sufficient if a few experiments were made to ascertain the load which a given material would bear before rupture took place, and the engineer was held to have done his duty if he proportioned his structure so that the load never exceeded a certain fraction of this breaking load, this fraction bearing the imposing name of "factor of safety." Some engineers held that a factor of safety of 10 was necessary, others, less conservative, were satisfied with lower proportions, but the whole consideration of the matter was empirical and arbitrary, and had no basis in any real knowledge of the true behaviour of the material under stress.

With a more scientific study of the manner in which various material resisted the action of stresses a more rational view of the subject began to obtain, and at the present time the whole tendency of the ablest engineers is to get entirely away from empirical formulas and methods and to consider each material by itself according to the actual conditions of use. This point of view has brought into prominence the fact that long before the breaking load is reached a material suffers molecular changes which render it unfit for further loading to any extent.

The improvements in testing machines and in the apparatus for recording the relation of load to deformation have taught us much concerning the true behaviour of materials under stress, and in an article upon the deformations of materials, by M. H. Bouasse, in a recent issue of the *Bulletin* *de la Société d'Encouragement pour l'Industrie Nationale,* this side of the subject is discussed in a very interesting manner.

M. Bouasse emphasises the necessity of differentiating the work of the engineer in the study of materials from that of the physicist. The latter, in his laboratory may undertake investigations of a high degree of precision, and the results, wholly accurate and interesting may yet be of comparatively small value for the purpose of forming the broad generalizations necessary for the framing of laws and formulas for the working engineer.

Taking up the much-discussed question of the limit of elasticity, M. Bouasse examines the case of a wire subjected to a load increasing in proportion to the time, and gives the diagram corresponding to the conditions of stress and strain. He emphasises the fact that there is no abrupt or sudden change in the curve indicating a precise point at which the extensions cease to be directly proportional to the loads, the rate of stretch increasing gradually, forming a rounded corner in the diagram. In other words, a pronounced region of inflexion is found on the curve, but not an abrupt angle. At the same time he admits that an approximation to the true limit of elasticity may be deduced from such a record, and considers that such an approximation may safely be used in the practice of machine design. M. Bouasse puts himself on record as affirming that the ultimate breaking load is of no scientific value whatever, so far as the researches of the physicist are concerned, although it is possible that it may be of some service to the engineer.

The law of Tresca is cited as of especial value to the engineer, this principle being that, with repeated removals and re-applications of the load in the testing machine, the curves drawn will practically coincide so long as the stress is within the elastic limit; practically such curves are straight lines of very slight inclination.

M. Bouasse examines in detail the complex phenomena which accompany the production of deformations in materials, and considers the influence of various methods of producing deformations upon the results. Thus it is quite possible to apply loads in such a manner as to permit altogether erroneous conclusions to be drawn, and unintentional or premeditated deceptions may be produced. A series of tests, alike in all respects with the exception of the speed of application of the load revealed the influence of the time element, a heavier load being required to produce the same extension in a short time than is necessary when the force is applied more slowly.

When it is understood that a difference of 10 per cent. or more in the apparent strength of the material may appear from this source alone, the importance of considering the time element is evident. This difference is that due alone to the behaviour of the material under rapid test, and is in addition to the error which may be caused by the inertia of the operative parts of the testing machine itself.

The influence of local hardening of the material under test is examined at length by M. Bouasse, and he shows very clearly that any assumptions based on a supposed uniformity of conditions throughout the whole test piece may lead to very misleading results.

So far as actual testing is concerned, the investigations of a material may be made according to three different methods. In the first case the material may be examined in connection with the completed structure of which it forms a part, as, for example the metal of a tire, in place upon the wheel where it is to be used. In such cases, theoretical considerations are entirely out of place. The important matter is to reproduce, as nearly as possible, the actual conditions under which the object is to be used.

The wheel may be broken under a hydraulic press, but the conditions imposed by the artillery tests are more practical, these consisting in placing the wheel upon a caisson or a gun carriage, and hauling it over several hundred kilometres of broken country.

The second kind of test includes the material before it has reached the final form and position of actual use. In such instances the final destination of the material may even yet be indeterminate. Here the only requirement should be the conformity of the piece under test to certain stated requirements of specifications, or its correspondence to a given standard of comparison. Even here a theory of deformations is inapplicable, and while the results may be of the utmost importance and value in construction, they are altogether unsuitable to be used as the basis of a scientific theory. In the third kind of tests the whole aim should be the procuring of data from which to deduce the theory and the actual laws of deformation. Such testing is the proper work of the physicist, to be performed in the laboratory, entirely apart from the practical considerations which must control actual working tests of the two previous classes. Only by the comparison of a vast number of laboratory tests can the true scientific laws of the deformation of materials be determined, but when thus determined, they will be rational and not empirical laws, capable of practical applications of the highest value.

ELECTRICITY IN MANUFACTURING PLANTS.

THE RELATIVE ADVANTAGES OF GROUP AND INDIVIDUAL DRIVING OF MACHINERY IN SHIPBUILDING AND MACHINE WORKS.

Society of Naval Architects and Marine Engineers.

SEVERAL years ago the question of equipping some government shipyards was under consideration, and there was some uncertainty as to the practicability of introducing electric transmission instead of shafting, belting and steam piping. To-day the only question in such a connection is as to the choice of electrical methods of transmitting and driving, all other methods being out of consideration. With this as his text, Mr. Walter M. McFarland presented a very interesting paper upon the use of electricity in manufacturing plants, before the recent meeting of the Society of Naval Architects and Marine Engineers, and his experience, both in naval affairs and in applied electricity, renders his opinions of especial interest.

A few years ago the steam engine was the only prime mover considered at all, either in shipyards or any other manufacturing works. The transmission was a combination of line shafting, countershafts and belting, and the greater part of the whole transmission system had to be driven whether one or all the machines were to be operated. The difficulties of such a centralized power system, with its attendant distribution problems, has led to the use, in shipyards and in widely extended manufacturing establishments, of a number of separate boiler houses, supplying steam to small engines placed near the machines to be driven. This method involved the use of small, wasteful engines, in the place of larger and more efficient ones, together with all the losses and inconveniences of steam pipe-lines, but the advantages of sub-division often overbalanced these objections. Pneumatic transmission has been introduced for the special tools for which it is so well adapted, and hydraulic power is employed for large riveters and flanging machines, but these have formed minor portions of any large plant.

"The disadvantage of long lines of shafting was thoroughly realized before electricity offered such a simple solution of the difficulty. Unless the greatest care was used in keeping the shafting in alignment and the journals well oiled, the power wasted in the friction of bearings and belts was a very large percentage of the total power of the engine. The results of numerous experiments to determine these losses have been published repeatedly, and show that they have varied from 8 or 9 to 80 per cent. of the power of the engine. That there should have been even the minimum loss when all the tools were in operation was bad enough, but unfortunately, from the nature of things, this loss was going on all the time, even when only a few tools were in operation, as it was practically constant and independent of the load. A preliminary solution of this difficulty was to divide the shafting into short lengths, driving groups of tools and operating each group by a small steam engine, but this introduced the lower efficiency of small engines and the complication of long lines of steam piping with the inevitable losses due to condensation. There was also involved additional supervision, as each engine would generally require a considerable part of the time of a man to look after it. With the case of a very large establishment with numerous power plants scattered over its area, the conditions were still worse for economy, as it was practically impossible to have the best skill at each one of these little plants, and, as a rule, they themselves were not economical.

"When we compare the conditions obtaining with electric transmission, the contrast is very great. Instead of the long lines of steam piping with their attendant condensation and heating of the spaces through which they pass, we have the small flexible wires conveying current, which can go anywhere and as a rule are located in spaces not useful for other purposes. Both generators and motors have a high efficiency and, speaking generally, the part of the apparatus requiring skilled attention is almost entirely concentrated in the power plant. There are no losses from condensation, and the analogous loss, that due to the heating of the wires consequent upon transmitting the current, is, for the distances common in industrial establishments, so small as to be a matter of little moment. The electric motors lend themselves readily to small subdivisions of power, the efficiency of small motors being only a little less than that of large ones as contrasted with the enormous reduction in economy of small steam engines. In consequence it is practicable to use the motors either for individual tools or for groups of tools. In either case, there is no loss comparable to that of driving the long lines of shafting and belting to operate a few tools, and power is only supplied in proportion to the actual call for it, for even in the case of group driving the groups would be relatively small and of such a nature that it would rarely be the case that a whole group would have to be driven to give power to a single tool."

The introduction of electricity in manufacturing plants has been gradual, beginning with electric lighting, followed by the employment of the current for operating machines for which the ordinary methods were difficult of use, such as travelling cranes and similar machines. The great convenience of these applications, and the existence of a supply of current in the shop led to its continual extension whenever small amounts of power were wanted at points not already conveniently supplied, a single motor at first being used to drive a countershaft for several tools, the *so-called* "group" system, followed by the still more highly differentiated method of providing an individual motor for every machine.

"Considered alone and for the individual tool, the individual drive is ideal. It enables the power to be applied just when wanted and only when wanted, and further enables each tool to be used under conditions of maximum efficiency. The objection will occur at once, however, to any practical man, that the enormous multiplication of small motors means increased complication and greatly increased cost. For example, the cost of a ten horse-power motor is very far from being ten times the cost of a one horse-power, and although, as stated above, the efficiency of small motors does not fall below that of large ones to any such extent as the difference between small and large steam engines, nevertheless there is a material difference. Some engineers go so far as to say that they would have a motor for each tool, even if it involved going to sizes as small as one-quarter horse-power, but the writer is inclined to believe that the judgment of more conservative engineers is favorable to individual driving where the power required will be, say, from five to ten horse-power and upwards, and for group driving where the individual tools would require less than those amounts. In any large plant there are numerous small tools, such as drill presses, screw-cutting machines, light lathes, etc., which are in any case located together, and where it is perfectly easy to drive them as a group. The average power required for such a group will be quite uniform, and when they are group driven a moderate sized motor, with its relatively high efficiency, can be used with a fairly steady load, thus contributing to the efficiency of the general system, as well as of the particular group, and reducing the first cost of the installation."

Mr. McFarland examines at length the relative adaptability of the continuous-current motor and the induction motor for machine driving. This is undoubtedly a matter of controversy at the present time, and there are valuable features in both systems. The direct-current motor has the advantage of variable speed, and having been the first in the field it has had the advantage of familiarity and experience. The induction motor is by far the simpler machine, and possesses a high efficiency, but, unless specially arranged it is a constant-speed machine, and requires the intervention of cone pulleys and belting between it and the machine. This is not altogether an unmixed evil, since the arrangement is scarcely more complicated than the commutator construction of the direct-current machine, and further the advantage of the "low-gear" effect of the cone pulleys on slow work is often desirable, slow speeds usually being accompanied with heavy demands for power.

The various systems of multiple wiring and multi-voltage are examined by Mr. McFarland, and the future possibilities of these methods are indicated.

"A feature of great interest in connection with the use of electricity is its cost as compared with that of older methods. Before giving some figures of a careful test which was made of the two systems, it may be remarked that in a thoroughly efficient plant it is probable that the cost of power rarely exceeds from 5 per cent. to 10 per cent. of the total cost of the product, so that it is obvious that even a very large percentage of saving in the cost of power will not reduce the total cost of the product very materially. Nevertheless, in a very large plant the saving would be quite respectable. The truth is that while the electrical system of transmission does secure a material reduction in the cost of power, this, after all, is not its greatest recommendation. The greatest benefit comes from the elasticity of the plant consequent upon its use. There is no longer any necessity for the rigidity of arrangement which obtains with shafting and belting, so that if it becomes necessary to rearrange the plant at any time the expense is reduced to a minimum. In the New York Shipbuilding Co.'s plant, for example, many of the tools being absolutely self-contained were not secured to foundations at all, and could be moved to any position desired, although these tools are not of the kind ordinarily considered as portable. The use of individual motors. and the consequent reduction in the amount of shafting and belting employed, makes the shops very much lighter, and gives overhead freedom for crane service with attendant increase in economy of production due to the greater efficency of the employees working in better light.

"To sum up, we may say that by the use of electricity for power transmission we secure an enormous increase in the flexibility of design of the plant, being able to locate the power plant itself and the various shops where the circumstances of the case require them for efficiency, the lines for transmission being so small as to make moderate variation of length unimportant. We also secure a marked economy in the cost of power, a greater efficiency in the machine tools themselves, and a greatly increased efficiency of the personnel, due to the increased habitability and cheerfulness of the shops."

GAS ENGINES FOR FURNACE GASES.

THE UTILIZATION OF LEAN FURNACE GASES FOR THE ECONOMICAL PRODUCTION OF MOTIVE POWER.

American Society of Mechanical Engineers.

AT the recent meeting of the American Society of Mechanical Engineers a paper was presented by Mr. Charles H. Morgan, describing a design of internal combustion motor especially designed for use with the lean gases discharged by blast furnaces, and the paper and the discussion which it elicited draws attention to this important source of motive power.

Mr. Morgan's design presents a number of valuable points, including the use of several cylinders, connected to rocking beams, enabling the mechanical efficiency of the machine to reach a maximum, while the valve gear is so arranged as to give a two-cycle effect in each cylinder, with a thorough scavenging of burnt gases each stroke, before the admission of the fresh charge.

Mr. Morgan referred to the statement of Mr. Campbell, that the gas engine was a "cannon with its projectile fastened to a crank shaft," but it is clear that this definition was an erroneous one, derived from the old Otto and Langen engine, in which the piston was a projectile, it is true, but not fastened to the crank shaft, since the upward movement of the piston was free, and the effective stroke was the downward one, due to the suction following the explosion, there being only a ratchet and pawl connection of the rack piston rod to the pinion and shaft.

Mr. Morgan calls attention to the value of waste furnace gases as a source of motive power, and recognizes the difficulties which attend their successful use.

"Like the dependence of the steam engine upon its boiler for uniformity and quality of steam so is that of the gas engine upon the producer for suitable gas. Nor is such gas easily obtained. Blast furnace and producer-gas, especially the former, contain large amounts of dust which comes from the ores, limestone and ash, and which is driven out with the blast. This dust has been the *bete noir* of the gas engineer in attempted utilization of the gas. Clogging the checker work and flues when used for reheating, impeding combustion when burned under boilers, and cutting and grinding vital parts of the machine when used in gas engines. Various devices for 'washing' or eliminating the dust have been devised, when, in the year 1900, German engineers discovered the value of passing the gas through a simple centrifugal fan blower injected with a small spray of water. The result has been exceedingly promising and when perfected will doubtless solve the troublesome problem."

In discussing the paper, Mr. B. H. Thwaite, himself identified with the earliest efforts to utilize these sources of motive power in the wastes of blast furnaces, called attention to the fact that the lean gases, of low calorific power, such as are obtainable as a by product of the manufacture of iron, are the very ones which enable the highest thermal efficiency to be secured in internal-combustion motors. A rich gas enables a larger power to be secured from an engine of a given size, but the lean gas, containing only 100 to 120 thermal units per cubic foot, is far more efficient when used in properly designed engines. Such gases require a smaller proportion of air to form the combustible mixture, the correct proportion being about 1 to 1, the principal requisite being a sufficiently high degree of compression in the cylinder. It is well known that a high compression is conducive to a high efficiency, but with a rich gas such a compression is impracticable because a temperature of compression is soon reached at which the mixture will ignite. With the lean gas a higher compression may be employed without any such risk, and in general it may be stated that the degree of compression should be inversely as the calorific power of the gas employed.

The magnitude of the question of the utilization of furnace gases may be gathered from the investigations of Mr. Uehling, who stated that he had determined the available power to be about 840 horse power per hour per ton of pig iron produced by the blast furnace. This computation is based upon the total calorific power of the gases discharged from the furnace, taking the thermal efficiency of the engines at 25 per cent., a rate which is decidedly within the limits of ordinary practical operation.

An interesting suggestion which has been made in this connection is that of the combination of ordinary and electric smelting, the blast furnace to be used to smelt the pig iron from the ore, and the electric furnace to refine the crude material to the finest steel, the power for generating the electric current being derived from the otherwise waste gases from the furnace. In this way the chief difficulty of electric refining—the cost of the power—may be eliminated, the pig iron being caused to furnish the power with which it is to be refined.

The utilization of furnace gases is one of the most important power problems of the present time. Many criticisms have been made of the wastefulness which has attended the exploitation of natural gas, and no condemnation can be too strong of the manner in which those vast natural resources of power have been squandered. All the time, however, we have been burning coal for the purpose of smelting iron and allowing a most valuable portion of the combustion to go to waste. The employment of a small portion of the heat in the waste gases to heat the blast and to fire the boilers has been admired as a noteworthy economy, while all the while a far greater portion of the energy in the coal has been lost.

Doubtless a partial reason for this indifference has been due to a feeling of uncertainty as to the reliability of the large gas engine. As Mr. Morgan says: "The gas engine has been looked upon askance. Its early life has been a synonym of unreliability. Echoes of its dying gasp as it came to a peaceful standstill, visions of workmen wrestling with the fly wheel to start it anew, are still fresh in the minds of users of power. Yet with all its faults it has gone on steadily from good to better things. The chance of cutting the best known steam engine economies a half or a third is a prize too tempting to ignore."

In this appreciation of the advantages of the gas engine for large powers, America has been far behind Continental Europe. Visitors to the Paris Exposition of 1900 will well remember the great 600 horse power Cockerill gas engine, and at that time its companion blowing engine of equal size was steadily operating at Seraing, day in and day out. In Luxembourg, in Belgium and in Germany, engines of equal size and larger have been built for several years as articles of general manufacture, and the names of Delamare-Deboutteville, von Oechelhaeuser, and Koerting, are well known as builders of such machines. Mr. Morgan will have done well if he does nothing more than to arouse the iron masters and coke burners of the United States to the fact that they are throwing into the air thousands upon thousands of dollars which their competitors are gathering in and utilizing, and if his paper and the discussion which it elicited but brings a realization of this waste home to those in whose power its control is placed, he will have rendered a great service to the industries of America.

THE LOCALISATION OF ENGINEERING SOCIETIES.

ADVANTAGES OF THE FORMATION OF BRANCH SECTIONS FOR THE DEVELOPMENT OF LOCAL INTEREST AND SPECIAL WORK.

Robert Kaye Gray—Institution of Electrical Engineers.

IN the course of a paper on the homes of the great engineering societies, published elsewhere in this issue, mention is made of the extent to which the Society of German Engineers has extended its work by the formation of local branches in all parts of the empire, these holding their own meetings under the general supervision of the main body. In connection with the recent revision of the constitution of the American Society of Mechanical Engineers this matter was also considered, and provision was made looking to the formation of such local branches when occasion should offer. As a portion of his recent presidential address before the Institution of Electrical Engineers, Mr. Robert Kaye Gray touched upon this important question, and his remarks may well be considered by other organisations at this time. Mr. Gray said:

"For the future development of the usefulness of the Institution there appears to me to be one matter worthy of our utmost attention. The Institution membership extends all over England and the Colonies, and we have found it a useful addition to our constitution to establish local sections in different centres. Since these sections have *been formed,* many valuable contributions have been incorporated in the Journal of the Institution which might not have appeared there, had the opportunity of having a meeting-place in the author's neighbourhood been absent, and had there not existed an organised assembly to discuss the subject submitted by him. The local sections are growing and must, by the nature of things, increase in importance. The development of the electrical industry in the provinces must advance with greater strides than in London, where manufacturers are hampered by high local rates, and sometimes obstructive legislation, which appears to be a necessity in our large metropolis, and which is, fortunately, not so essential in smaller communities. Again, in the neighbourhood of London the cost of raw material is appreciably higher; fuel is also higher, and the charges for the transport of the finished goods to their destination handicaps the London manufacturer. These, in addition to the higher scale of wages paid, are fast driving manufacturers into the provinces. Such a migration, from a general point of view, is perhaps advantageous; but it indirectly affects the Institution in a way which is not of advantage to the central body. If the migration continues to the same extent as took place in the case of London shipbuilding many years ago, the centre of production, so to speak, of the electrical industry will gradually gravitate northwards, and nothing but consumers will be left in the Metropolis. Many of our ablest members are already in the provinces, and it is quite a question for the Institution to consider whether the day is not fast approaching when we should extend our system of decentralisation. Is it not time that we should consider the establishing of a local section in London, similar in all respects to the local sections we have in Birmingham, Dublin, Glasgow, Leeds, Manchester, and Newcastle? In this new local section papers affecting London could be read, and be published or not in the Journal of the Institution in the same manner as papers in the other local sections are dealt with. London would continue to be the headquarters of the Institution, and Institution meetings could be held, say, four times a year. At these, papers of general interest could be contributed. If any such scheme as this were adopted, the constitution of the Council of the Institution would be somewhat affected. The Chairman and Committee of the London Local Section would, of course, be all London men, but the Institution would have a larger field from which to select its President and Council, as men who have their business in the provinces, and who cannot spare the time to attend the present numerous Council and Institution meetings, might be able to attend the less numerous meetings which would be the outcome of some such rearrangement."

While experience in Germany has not tended to minimise the interest which has been manifested in the work of the Society of German Engineers in Berlin, the activity of the local sections has done much to advance the work of the whole body, and the large membership of active engineers which has made the Society one of the most powerful in the world is undoubtedly due to this system. If such a plan works well in Germany it certainly offers possibilities both in the British Empire, and in the United States, where the wide distances which separate many of the members of professional societies from headquarters form a certain element of weakness.

The necessity for the localisation of the administration of a professional society in a metropolis is understood by all, and it would undoubtedly be well for the work of the profession if a strong centralised administration, under proper regulation, existed to direct the work of a number of societies, themselves occupying various branches of the great field of work. If, however, local members, themselves resident at a distance from the main headquarters, are to be kept interested in the work, it is desirable that they feel a closer connection with the objects and progress of the whole than can be secured merely by the receipt of an occasional volume of transactions or proceedings.

In the case of the branches of the German society, experience has demonstrated that the annual conventions, which are held away from the headquarters, are most energetically aided by the local sections in the vicinity of the meetings, and that a degree of national strength is thus obtained which could not be secured in any other manner.

It will be a matter of much interest to observe th extent to which the suggestion of Mr. Gray will bring forth fruit in the future conduct of the Institution of which he is the head, while developments in the same direction in other places may be made.

A STUDY OF CARBON VAPOR.

THE VAPORISATION OF CARBON FILAMENTS IN INCANDESCENT ELECTRIC LAMPS AT MODERATE TEMPERATURES.

M. Berthelot—Académie des Sciences.

CARBON is supposed to be one of the most infusible of elements and capable of being maintained for long periods of time in a state of incandescence without change when kept from access of oxygen. Since fusion is supposed to precede vaporisation it might seem that carbon vapor was a substance not often encountered, but as a matter of fact carbon vapor has a very practical significance.

It is well known that the bulbs of incandescent electric lamps gradually become blackened on the inside, and the effective illuminating power is thus very materially diminished with the lapse of time, while the filament also slowly wastes away. Since these occurrences take place in the highest vacuum which it is practicable to produce and maintain, it is evident that the solid carbon of the loop must in some way be converted into vapor and redeposited upon the inner walls of the bulb. These well-known phenomena have been most carefully investigated by M. Berthelot, and in a recent communication to the French Academy, published in *Comptes Rendus,* the general results of his experiences are given.

Assuming that the carbon of the filament is actually vaporised and deposited upon the glass, M. Berthelot proceeded to examine the conditions under which the vaporisation takes place, and to discover, if possible, the state of carbon vaporised at the lowest possible temperature, comparing it with the well-known states of carbon, diamond, graphite and amorphous carbon.

In order that the idea of maintaining a moderate temperature might be met, M. Berthelot explains that he took precautions to work with carbon deposits which were formed during various periods of incandescence, at temperatures of 1,200° to 1,500° C., and to avoid those bulbs in which the filament had parted. In this latter instance there is every probability that a higher temperature had momentarily existed, introducing rapid changes, impossible of study or verification.

M. Berthelot gives the details of his chemical treatment of the carbon deposits upon the interior of selected bulbs, showing that in all cases where the comparatively low temperature had been maintained, the carbon was wholly in the amorphous state, there being no trace of either graphite or diamond. With the tests made upon each bulb there were made comparative tests of the remaining portions of the unbroken filament, which, of course, had been subjected to the same temperature for the same period of time. These filaments, in the greater number of cases, had been prepared by the pyrogeneous destruction of certain vegetable fibres. In some instances an artificial fibre of cellulose formed the base, and in all cases a brief period of high incandescence sufficed to remove all traces of hydrogen or of other gases or vapors, so that in well-made lamps no appreciable vapor of carbon existed. New filaments, examined and tested with the same care as the carbon deposits, showed no traces of graphite. A similar examination of used filaments which remained intact, and hence had not been raised to the temperature of the spark, showed again no trace of graphite, being altogether amorphous. Since it is well known that graphitic carbon is produced at temperatures existing in the electric arc, it follows that the existence of graphite bears some relation to temperature, not being produced at comparatively low temperatures of incandescence.

Carbon vapor must possess an appreciable tension at incandescent white heat, about 1,200° to 1,500° C., but this tension must be very low, since several hundred hours are required to produce a few milligrammes of condensed carbon, even in the almost perfect vacuum of the incandescent lamp bulb. Since, according to Violle, the boiling point of carbon is about 3,600° C., it follows that vapor of an appreciable tension is formed at a temperature of about 2,000° C. below the boiling point, an interval which greatly exceeds that for other bodies which possess a vapor tension.

It is hardly correct, however, to compare the vapor of carbon with that of other well-known substances, such as water, alcohol, and the like. With these the phenomena of vaporisation is a purely physical question, the substance remaining the same throughout the successive stages of solid, liquid and vapor, the changes being wholly molecular, and involving a comparatively small expenditure of energy.

Carbon, on the contrary, while being always the same chemical element, presents itself in a variety of states when in the solid condition; these states possessing very dissimilar chemical and physical properties. Each of these forms of carbon appears to have its own molecular constitution and capable of forming its own series of combinations. M. Berthelot believes that the varying properties of these varying states of carbon extend to the conditions of vaporisation, and that the action of heat proceeds according to a progressive series of condensations, the various forms of carbon representing the limits of these condensations. This view is sustained by the enormous absorption of heat necessary, this being 8 to 10 times that required for the vaporisation of water, but being possibly demanded to effect the successive dissociations of the carbon. As an analogy of the behavior of compound substances, M. Berthelot cites the fact that the boiling point of hydrogen is —252°, and of oxygen, —182°, while their combination, water boils at + 100° C. The force which maintains the molecules of hydrogen and oxygen in the gaseous state has thus diminished in an enormous proportion, corresponding to a loss of 59,000 calories at the moment of their combination to form one molecule of the vapor of water. In like manner carbonic oxide, which boils at —190°, and oxygen, boiling at —182°, form carbonic acid, which boils at —78°, there being disengaged heat equivalent to about 68,000 calories.

Throughout the various changes in carbon during vaporisation its elementary condition is assured by the permanency of its spectrum, so that the normal atoms must remain unchanged. The study which M. Berthelot has made of the behavior and production of the vapor of carbon is interesting both from a theoretical and a practical point of view, since it leads to considerations which may show why its vapor is formed so far below its boiling point;—a fact of which the explanation may lead to the discovery of methods for its control, to the practical advancement of its application in the arts.

HIGH-SPEED TOOL STEELS.

DATA AND RESULTS OF TESTS ON LATHE TOOLS AT THE MANCHESTER MUNICIPAL SCHOOL OF TECHNOLOGY.

Manchester Association of Engineers.

FOR a time after the modern high-speed steels were introduced in general shop use the question of the real gain from their use was considered to be a debatable matter. Now, however, the question is not: "Shall we use high-speed steels?" but rather: "How shall we obtain the best results from them?" Under these circumstances all the reliable data which can be obtained of actual performances are to be welcomed, as conducing to the more intelligent use of modern tools.

The tests made by Dr. Nicolson, at the Manchester Municipal School of Technology, a report upon which was presented before the Manchester Association of Engineers, contains much valuable information, and some abstract of the results will indicate the general character of the investigations.

Eight different varieties of tool steel were tested, all the trials being made upon a special electrically-driven lathe, so arranged that cutting speeds from 12 to 200 feet per minute could be obtained upon a bar of 5 feet circumference. The power delivered was measured electrically, the proportion of lost power being computed by a formula experimentally deduced from trials with a Prony brake and from a belt dynamometer. The trials were made to determine *three different elements*: the maximum weight of metal which could be removed per minute, the maximum area of surface machined, and the maximum cutting speed attainable. The materials worked were forged steel and cast iron, each material being used in three grades, soft, medium, and hard. The results of the trials are recorded both in tabular form and in graphical diagrams, for which reference must be had to the report, but some of the conclusions may be given here.

In the first place the term high-speed must not be considered as relating wholly to the linear speed of the material under the tool, since the real question underlying the whole matter is the increased speed at which a given piece of work can be performed. It is the amount of material which can be removed in a given time which interests the constructing engineer, since the great workshop gain lies in the ability to substitute cheap and rapid lathe work for slow and expensive forging. The much-discussed question as to the consumption of power, to which Dr. Nicolson gives consideration, is altogether of secondary value, since the power required forms an unimportant element in shop costs compared with the influence of time, especially in connection with the distribution of establishment charges. The real influence which the cutting force has upon the study of the subject lies in its relation to the strains upon the machine tools, and in this important matter some of the conclusions reached by Dr. Nicolson are most interesting.

Broadly the conclusions obtained from the trials are as follows: The maximum amount of material is removed, not by using the maximum linear speeds, but by using the heavier feeds and cuts. Thus on soft steel, with a feed and cut both of 1/16 inch and a speed of 149 feet per minute, the amount of metal removed was 1.72 pounds per minute, while with a cut of ⅜ inch and a feed of ⅛ inch, the speed being reduced to 54 feet, the amount of metal removed rose to 7.35 pounds per minute. Similar results appear upon the different materials machined, and in general it may be stated that the relation of machining efficiency to speed shows that the highest linear speeds are not the most efficient.

Very interesting are the endurance trials, since it is often desirable to know whether a tool can be expected to last through a cut at a given rate of speed, cut, and feed. The life of the tool itself is of secondary importance, but the workman should be able to know beforehand the relation of all the working conditions in order to judge which combination of them to use for any given piece of work. The endurance trials on medium cast iron, with a cut of 3/16 inch, and a feed of 1/16 inch on a linear speed of 34 feet per minute showed that but three out of thirteen tools lasted more than one hour, and none of them held out for the proposed two-hour limit. An ordinary Mushet tool ran for an hour on the same material at a speed of 19½ feet per minute, while ordinary water-hardened tools failed in from four to nine minutes at a speed of 12 feet per minute.

The experiments confirmed what has been demonstrated elsewhere, that the resistance to cutting does not increase, and even appears to diminish, with increased cutting speeds, so that increased speeds do not necessarily involve heavier or stiffer machine tools. The heavier cuts and feeds, however, show almost proportional increase in power required, while at the same time a higher economy in power is obtained because of the greater return in useful work.

These experiments of Dr. Nicolson's supplement in a very interesting manner those of Mr. Carl Barth, mentioned elsewhere in this issue, and show how necessary some scientific study of operative conditions is in order that the maximum total efficiency of the new steels be obtained. Mr. Barth has taken the position that the working information about the steels and the various materials to be worked can be gathered and arranged so that the workman may be governed by the experience obtained and thus all the mass of accumulated shop experience with the old steels can be put aside in such a manner as to prevent it from hampering the new materials in practical use. The workman, using his special slide rule or diagram, can select at once the proper speed, feed, and cut for the work in hand, and all uncertainty is eliminated.

Much of the data gained by Dr. Nicolson will be available in the design of lathes for use with modern steels, and by choosing the speeds and feeds found to be the most useful and efficient the working stresses upon the various parts of the machine may be determined to a far higher degree of precision than has ever been practicable under former conditions. Not the least of the benefits which has resulted from the investigations is the collection of definite data suitable for use with problems in machine design, and if this point is kept in view future trials may be rendered of still greater value.

A SWISS MECHANICAL LABORATORY.

THE NEW EXPERIMENTAL ENGINEERING DEPARTMENT OF THE NATIONAL POLYTECHNIC SCHOOL AT ZÜRICH.

Schweizerische Bauzeitung.

AMONG the scientific educational institutions of Europe the Zürich Polytechnic has always held a very high place, and the names of Reuleaux, Zeuner, Clausius, and others have been most creditably followed by those of Prasil, Stodola, and their associates. Space in the main building having become inadequate, an entirely new and independent building has been constructed, and is now in full and active service, and from a very complete account in recent issues of the *Schweizerische Bauzeitung* we abstract some account of the place and the work which is there being accomplished.

Three departments of experimental engineering are provided for in the building, these being designated as the "caloric," the "hydraulic," and the "electrical" laboratories.

The so-called "caloric" laboratory includes the appliances for the experimental study of all kinds of heat engines, as well as of refrigerating machinery, together with steam boilers and gas producers, and the necessary auxiliary apparatus. The main experimental engine, which forms the principal motor in this department, is especially interesting, since it represents the work of two of the eminent firms of engine builders in Switzerland. It is primarily arranged to be a triple-expansion horizontal engine, the high pressure and the low-pressure sections being constructed by Sulzer Brothers, of Winterthur, while the intermediate portion is from the works of Escher, Wyss & Co., of Zürich. On the shaft between the high and intermediate cylinders is placed a Thury direct-current dynamo, built by the Société de l'Industrie Electrique, of Geneva, while on the second portion of the shaft is a grooved fly-wheel pulley for use with rope transmission, and also the rotor of a polyphase generator by Brown, Boveri & Co., of Baden. The two portions of the shaft are connected by friction couplings, so that either can be operated independently, in connection with the fly wheel. The three cylinders are all provided with different varieties of valve gear, the high-pressure cylinder having the standard Sulzer poppett-valve system, controlled by a Porter governor. The intermediate cylinder is fitted with corliss valves, operated by the Frikart valve gear, having two eccentrics, so that the cut-off may be varied between 0 and 70 per cent., without affecting the compression. The low-pressure cylinder, while fitted with Sulzer valves, has the modified valve gear of Radovanovic, permitting variable compression, this also being provided with an inertia governor by Zabel & Co.

It will be seen that this interesting machine represents the work of a number of the most noted makers of Switzerland, and that its flexibility permits of a great variety of investigations upon the action of steam to be made. Thus, the cylinders may be operated as independent simple engines, or as compound engines in two combinations. The low-pressure cylinder can also have its valve gear reversed, and a supply of cooling water run through the steam jacket, in which case it is available as an air-compressor with mechanically operated valves, being driven by the other two cylinders. Any one of the three governors may be connected to any of the valve-gears, so that their action may be compared under various conditions.

A number of smaller steam engines enable the work of this principal machine to be supplemented in an effective manner, and a great variety of experimental research work is here performed.

Besides the reciprocating steam engines the laboratory is provided with steam turbines, upon which Professor Stodola has made some most important original investigations, together with gas engines, refrigerating machines, pumps, condensers, and the necessary machine tools to enable the special fitting and connections to be made for any original experimental work.

The hydraulic section of the laboratory, while well equipped and provided with means for numerous original investigations, lacks the great advantage which accompanies the presence of a natural source of water power. The situation of the building, upon the hill above the older portion of the city of Zürich, deprives it of this advantage, but an ample provision of water tanks enables the steam-power section to employ its energy in driving the pumping machinery to maintain the water supply, and thus the two departments work together.

By the combination of tanks, centrifugal pumps, weirs, and general hydraulic machinery this laboratory has been made very complete for the conduct of the more refined experimental researches in hydraulics, and under the skilled supervision of Professor Prasil, some valuable original work has been done in addition to the regular routine of instruction. Among these may be noted experiments on water jets on high-pressure centrifugal pumps, on compound turbines, and similar work, the whole contributing to original knowledge, as well as forming most effective material for instruction.

With such a complete mechanical laboratory, in such skilful hands the reputation of the Zürich Polytechnic cannot fail to be maintained at the high standard which has attended its career in the past, and to this standard institution, as well as to the larger, but not higher Charlottenburg the attention of those interested in the advancement of technical education should be directed. Any one who has examined the nature of the work which is done at such institutions cannot fail to realize that young men who have been through such practical and scientific investigations must be far more valuable in the manufacturing and engineering establishment after even a few months of shop experience that the brightest boy who has ground through the old course of apprenticeship. If such training does not conduce to money value, and still more to national progress, the difficulty lies, not with the students and not with the system of education, but with the employers, with the statesmen, and with the industrial conditions which fail to use the opportunities which the educators are preparing for them.

This whole question of laboratory training for the engineer has been discussed again and again, but the fact that the great educational institutions continue to enlarge and extend their facilities in this direction shows very clearly the opinion of the foremost technical instructors. That this should be so is wholly in accordance with the development of modern engineering methods. The skilled workman must always be in demand, and there is no reason for fear that work will not remain for him to do, but the whole tendency of the times in engineering work is to consider each large problem anew, and to devise means for doing it as fully as may be by the methods best adapted for the special case. To attack such questions intelligently and to treat them with the broad judgment necessary for success ordinary methods of training, whether in the class or lecture room or at the workbench, will not suffice. The student must be obliged to make independent investigations on his own account. He must learn to weigh a problem and decide for himself how he will attack it, and he should have his methods and results so checked and supervised that he shall realize that his work must be honest and sincere.

For such training two things are essential; the place in which to do the work, and the instructors under whose intelligent and watchful care the work shall be done. The place includes the mechanical laboratory, an excellent example of which is seen in the new structure at Zürich, while the instructors must be found, and fortunate is the educational institution which finds them. Here again appears one of the important advantages of laboratory work in engineering. When the professor is obliged to go into the details of original research with his pupils there is no room for the pompous mystery with which the old-time teacher often successfully concealed his incompetence. Lectures may be prepared from text books, and examinations may be held under rules framed entirely from the instructor's side of the game, but when the laboratory work begins the professor is as much upon his trial as is the student, and there is no one more prompt to see any evidence of weakness or uncertainty than this same student, should occasion arise. In the mechanical laboratory all shams and deceptions must be cast aside, just as they disappear in the practical work of daily life which follows the school, and not the least of the benefits of laboratory instruction in engineering is the introduction which it thus forms to the coming occupations of the students.

There is small doubt that the value of the technical school will come to be largely judged by the facilities which it offers for practical laboratory work of a high class, and under such a test the Zürich Polytechnic will assuredly retain the place which it has always held in the past. Such an institution can always make its own record by the character of original research work which it undertakes, and by the contributions to knowledge in the department of science to which it belongs.

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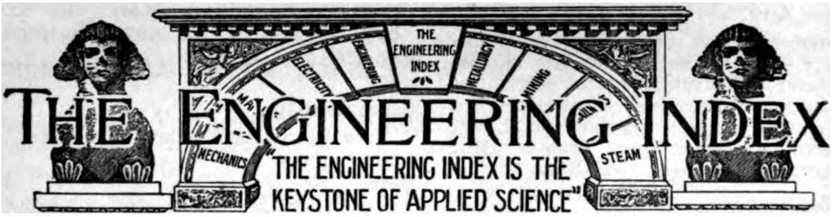

THE ENGINEERING INDEX

"THE ENGINEERING INDEX IS THE KEYSTONE OF APPLIED SCIENCE"

The following pages form a DESCRIPTIVE index to the important articles of permanent value published currently in about two hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every article.

(1) The full title,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published.

We supply the articles themselves, if desired.

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer and works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of any article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the journals indexed are given.

DIVISIONS OF THE ENGINEERING INDEX.

CIVIL ENGINFFRING.................. 603
ELECTRICAL ENGINEERING.....'........ 608
GAS WORKS ENGINEERING............ 614
INDUSTRIAL ECONOMY................. 615
MARINE AND NAVAL ENGINEERING.... 616
MECHANICAL ENGINEERING............ 618
MINING AND METALLURGY............ 625
RAILWAY ENGINEERING................ 630
STREET AND ELECTRIC RAILWAYS...... 634

CIVIL ENGINEERING

Arch.

A Concrete Arch Bridge Near Mechanicsville, N. Y. Illustrated description of a three-arch highway bridge. 600 w. Eng News—Nov. 5, 1903. No. 58863.

Bridge Repairs.

The Kansas City Flow-Line Bridge Repairs. J. A. Waddell. Illustrated detailed description of repairs made to the bridge over the Kaw River that carries the pipes for the water supply of Kansas City, which was badly damaged by the recent flood. 6000 w. Eng Rec—Oct. 31, 1903. No. 58761.

Cantilever.

The Reconstruction of the Frans Bridge (Reconstruction du Pont du Frans). Illustrated description of the new Cantilever bridge across the river Saône at Villefranche, replacing the former suspension bridge. 2000 w. 1 plate. Génie Civil—Oct. 31, 1903. No. 59112 D.

Collision.

A Collision with a Swing Bridge at Toledo, O. R. G. Manning. Illustrations showing the damage done, with account of the accident. 700 w. Eng News—Nov. 26, 1903. No. 59257.

Concrete Arch.

Concrete Bridge Over the Big Muddy River; Illinois Central R. R. H. W. Parkhurst. Illustrated detailed description of a bridge having three elliptical arches. each of 140 ft. clear span and 30 ft. rise above the springing lines. 6000 w. Eng News—Nov. 12, 1903. No. 58975.

Floor Construction.

The Protection of Steel in Ballasted Floor Bridges. An illustrated article giving the practice of different railways in regard to solid floor construction. 3800 w. Eng News—Nov. 12, 1903. No. 58978.

Loadings.

Loadings for Railroad Bridges. Extracts from a discussion at the June meeting of the Am. Soc. of Civ. Engrs., with editorial. 4000 w. R R Gaz—Nov. 20, 1903. No. 59218.

Railway Bridge.

Erection of the Grand Rapids Bridge. Illustrated description of the erection of a single track bridge with seven 175-ft. through Pratt truss pin-connected spans and two 50-ft. plate-girder deck spans. 1300 w. Eng Rec—Nov. 7, 1903. No. 58840.

Reinforced Concrete.

Armoured Concrete Foot-Bridge at Toulouse. Illustrates and describes the novel features of a bridge having a span of 139 ft. 1200 w. Engr, Lond—Nov. 13, 1903. No. 59082 A.

Short-Span.

Standard Short-Span Bridges on the Atchison, Topeka & Santa Fe Railway. Illustrates and describes the standard designs for single track structures up to spans of 106 ft. 2700 w. Eng Rec—Nov. 14, 1903. No. 58962.

Specifications.

A Comparison of the Requirements of Recent Railway Bridge Specifications. A. H. Heller. Gives a table showing a summary of such requirements as depend mostly on the engineer's judgment. Also much valuable information. 4000 w. Eng News—Nov. 19, 1903. No. 59022.

Suspension.

Comparative Eye-Bar and Wire Cable Designs for a Highway Bridge Over the Rhine at Cologne. Illustrates and describes two proposed designs for a suspension bridge. 1000 w. R R Gaz—Nov. 20, 1903. No. 59216.

Swing Bridge.

An American Bridge Built of German Steel and Launched at a Shipyard. P. S. Hildreth. A statement of the conditions and explanation of interesting features involved in the construction of a swing bridge at Fore River, Mass. Ill. 800 w. Eng News—Nov. 19, 1903. No. 59025.

CANALS, RIVERS AND HARBORS.

Canal Haulage.

See Electrical Engineering, Power Applications.

Dams.

A Hollow Concrete-Steel Dam at Theresa, N. Y. Sectional drawing photographs and brief description of a dam of reinforced concrete. 450 w. Eng News—Nov. 5, 1903. No. 58861.

Review of the Report of the Charles River Dam Commission. Leonard Metcalf. Substance of the very interesting report of the Massachusetts Commission. 5000 w. Tech Rev—Oct., 1903. No. 59034 C.

Dredge.

Combined Suction and Bucket Dredger. Illustrated description of a high-powered dredger for the port of Montevideo. 400 w. Engr, Lond—Nov. 13, 1903. No. 59081 A.

Dredging.

A Desirable Method of Dredging Channels Through River Bars. S. Maximoff. A short description of the present conditions of river navigation in Russia and of the Government's dredging fleet, with detailed descrintion of method proposed by the writer. Ill. 4300 w. Pro Am Soc of Civ Engrs—Oct., 1903. No. 58705 E.

Dry-Dock.

The Carena Dry-Dock, Argentine Republic. Describes a dock recently finished, proportioned to receive the largest ships yet built. Ill. 1200 w. Eng Rec—Nov. 14, 1903. No. 58956.

Mississippi.

The Levee Theory on the Mississippi River. Continued discussion of whether the levee theory is justified by experience. 9500 w. Pro Am Soc of Civ Engrs—Oct., 1903. No. 58710 E.

CONSTRUCTION.

Apartment Hotels.

The Apartment Hotel in New York. Reginald Pelham Bolton. An illustrated description of the "Ansonia" which contains 340 suites, comprising 1600 rooms and 345 bath-rooms. 2800 w. Cassier's Mag—Nov., 1903. No. 58893 B.

Beams.

Some Applications of the Principles of Least Work. (Einige Anwendungen des Satzes der Kleinsten Formänderungsarbeit). Charles Abeles. A mathematical investigation of the distribution of stresses for various loadings of beams. 2500 w. Zeitschr d Oesterr Ing u Arch Ver—Oct. 30, 1903. No. 59122 D.

Building Construction.

The Pabst Hotel and Majestic Theater. Illustrated detailed description of a four-story, steel-cage, fireproof building recently erected in New York. 2000 w. Eng Rec—Nov. 7, 1903. No. 58839.

Concrete Masonry.

Concrete Masonry on the Lu Han Railway. Extract from a paper by Thomas J. Bourne, read before the Inst. of Civ. Engrs. of Great Britain, describing some interesting work in China. 900 w. R R Gaz—Nov. 6, 1903. No. 58873.

Cribs.

Holding Power of Ballast in Timber Cribs. An account of experiments made at Duluth, Minn., and described in the Report of the Chief of Engineers, U. S. A., for 1902. 1000 w. Eng Rec—Nov. 7, 1903. No. 58841.

Falsework.

Falsework for Rocky Bottoms in Rapid Currents. From the report of the committee of the Bridges and Buildings Assn. Illustrations with brief descriptions of designs where piles cannot be driven. 1000 w. R R Gaz—Oct. 30, 1903. No. 58784.

Foundations.

Construction with Compressed Air (Construction par l'Air Comprimé). A description of the pneumatic process employed in the construction of the foundations of the new dry docks at the port of Kiel. 1800 w. 1 plate. Génie Civil—Oct. 24, 1903. No. 59111 D.

Pile Sinking.

Machine for Sinking Screw Piles. An illustrated description of the apparatus which has been designed for sinking the piles upon which the tunnels of Pennsylvania R. R. will rest. 800 w. Ir Age—Nov. 12, 1903. No. 58856.

Roads.

Maryland Road Specifications. Extracts from specifications for the construction of macadam and telford roads, giving the essential features. 1200 w. Eng Rec—Nov. 7, 1903. No. 58843.

Tunnels.

Hudson River Tunnel of the New York & New Jersey Railroad. Outlines the past history of this work and an account of the resumed work, giving drawings. 1800 w. R R Gaz—Nov. 27, 1903. No. 59263.

Improvements in Tunnel-Boring Practice in London for Deep-Level Railroads. Brief description of methods employed in tunneling beneath the River Thames. 1800 w. Sci Am—Nov. 21, 1903. No. 59028.

Manhattan and Weehawken Shafts of the Pennsylvania Railroad Tunnels under the North River. Illustrations with brief account of the work. 1200 w. Eng Rec—Nov. 14. 1903. No. 58963.

The Brooklyn Tunnel of the New York Rapid Transit Railroad. Illustrated description of details and progress of the work on the tunnel from the Battery, New York, to Brooklyn. 1800 w. Eng Rec—Oct. 31, 1903. No. 58764.

The Construction of the East Boston Tunnel of the Boston Subway System. Robert H. Farwell. Interesting information in regard to the material encountered, construction work, etc. Ill. 3700 w. Eng Rec—Nov. 7, 1903. Serial. 1st part. No. 58838.

The General Problem of Tunneling under Rivers. Editorial on methods of construction, requirements, etc. 1200 w. Eng Rec—Oct. 31, 1903. No. 58759.

The Pennsylvania Railroad Tunnel Under New York City. General plan of this great undertaking, with four insets. 2500 w. Ry Age—Oct. 30, 1903. No. 58750.

Walls.

A New Type of Reinforced Hollow Tile Wall Construction. Illustrated description of walls for mill buildings made of hollow tiles bonded with strap iron—the "Phoenix" hollow tile wall. 600 w. Eng News—Nov. 5, 1903. No. 58871.

MATERIALS.

Cement Mortar.

Effect of Clay and Loam on Cement Mortar. C. E. Sherman. An account of bridge construction in Yellowstone National Park, describing the material used, and giving results of tests made. 2000 w. Eng News—Nov. 19, 1903. No. 59021.

Cement Plant.

The Plant of the Buckhorn Portland Cement Co. Richard L. Humphrey. Illustrates and describes an interesting plant in W. Va., built on the side of the mountain from which the raw material is obtained. 3000 w. Eng News—Nov. 5, 1903. No. 58864.

Concrete.

Impervious Concrete. Sanford E. Thompson. A contribution to the discussion as to whether it is possible to make a concrete which will be impervious to water. 1100 w. Pro Am Soc of Civ Engrs—Oct., 1903. No. 58706 E.

Flooring.

New Flooring Material. Illustrates and describes a system of concrete flooring, consisting of hollow tubes of mortar and iron. The Siegwart beam. 900 w. U S Cons Repts, No. 1802—Nov. 16, 1903. No. 58988 D.

Reinforced Concrete.

The Determination of the Rectangular Section of a Reinforced-Concrete Beam

(Bestimmung des Rechbeckigen Querschnittes eines Armierten Betonträgers). G. Ramisch. A mathematical discussion deriving general equations for beams of reinforced concrete, with practical applications. 2000 w. Zeitschr d Oesterr Ing u Arch Ver—Nov. 6, 1903. No. 59123 D.

See Civil Engineering, Bridges.

See Civil Engineering, Canals, Rivers and Harbors.

See Civil Engineering, Water Supply.

Soapstone.

Norwegian Soapstone. An illustrated article describing this stone, and the quarries. It is valued as a building stone. 1800 w. Quarry—Nov., 1903. No. 58904 A.

Stone.

Analyses and Particulars of British Stone. The first of a series of articles giving particulars and tests. 1000 w. Quarry—Nov., 1903. Serial. 1st part. No. 58905 A.

Timber.

Fungous Diseases of Forest Trees. Hermann von Schrenk. An explanation of how trees are infected, the rate of decay, treatment, remedies, etc. Ill. 6000 w Bul Internat Ry Cong—Oct., 1903. No. 58720 E.

MEASUREMENT.

Surveying.

Recent Rapid Base-Line Measurements, Precise Leveling, and Triangulation. A. L. Baldwin. An illustrated article giving an account of the work of the U. S. Coast and Geodetic Survey. Also discussion. 3700 w. Pro Engrs' Club of Phila—Oct., 1903. No. 58702 D.

Topographical Surveying. W. C. Bunnel, Jr. Notes showing what has been done, and the results obtained. Discussion. 5000 w. Jour W Soc of Engrs—Oct., 1903. No. 59275 D.

MUNICIPAL.

Garbage.

The Latest Garbage Disposal Statistics. Editorial review of a paper by C. E. A. Winslow and P. Hansen, presented at the Washington meeting of the Am. Pub. Health Assn. 2000 w. Eng News—Nov. 5, 1903. No. 58865.

New Orleans.

Sewerage and Plumbing in New Orleans. Editorial on the system employed. 1500 w. Eng Rec—Nov. 14, 1903. No. 58954.

Pavements.

The Development of the Kreodone Block Pavement. P. C. Reilly. Reports experience with wood block pavements in *Indianapolis,* and the recent improvements in material used, claiming the Kreodone block to wear well, and to be indifferent to wet, dry, heat or cold. 2500 w. Munic Engng—Nov., 1903. No. 59036 C.

Wood Paving Specifications in Greater New York. F. A. Kummer. Gives the specifications for streets, and also for bridge floors. 3800 w. Munic Engng—Nov., 1903. No. 59035 C.

Sewage.

Sewage Disposal at Hebden Bridge. Illustrates and describes a new installation in which chemical precipitation forms the principal feature. 1500 w. Engr, Lond—Oct. 23, 1903. No. 58737 A.

Liquid Sewage (Vloeibar Afval). D. J. Sanches. A comparison of the Liernur pneumatic system of sewage removal with the liquid bacterial purification method. 4000 w. De Ingenieur—Oct. 31, 1903. No. 59153 D.

Winter Treatment of Sewage Beds. Information from several sewage plants in various parts of the United States which have been successfully operated. Ill. 1800 w. Eng Rec—Nov. 14, 1903. No. 58959.

Sewers.

Construction of the Sixty-fourth Street Sewer Tunnel, Brooklyn. An illustrated description of a special arch-timber method of tunneling. 3200 w. Eng Rec—Nov. 21, 1903. Serial. 1st part. No. 59204.

Methods and Cost of Constructing a Concrete Sewer Having a Brick Arch, at Medford, Mass. Description from report of William G. Taylor, with illustrations. 1000 w. Eng News—Nov. 19, 1903. No. 59027.

Perviousness of Sewers. Abstract of a paper read by Prof. A. Prescott Folwell at the convention of the Am. Soc. of Munic. Imp. Gives reports of measurements made at several places, and briefly discusses the advantages and disadvantages of infiltration. 2800 w. Eng Rec—Nov. 7, 1903. No. 58842.

Tunneling for a Sewer Beneath the Cochituate Aqueduct. J. H. Kimball. Describes a difficult piece of work at Newton Highlands. 800 w. Eng Rec—Nov. 14, 1903. No. 58957.

WATER SUPPLY.

California.

Southern California's Mountain Water Company's Reservoirs, Dams and Pipe Lines. An illustrated description of portions of extensive development schemes, including dams, reservoirs, flumes and pipe lines. 3000 w. Eng Rec—Nov. 14, 1903. No. 58958.

Conduits.

The Construction of the Sixty-Inch Reinforced Conduits of Newark, N. J. Morris R. Sherrerd. Brief illustrated description of monolithic work. 1500 w. Munic Engng—Nov., 1903. No. 59037 C.

Wrought-Steel Conduits for Gravitation and Pressure Water Supply. Herbert Fetherston Lloyd. From the Pro. of the Inst. of Civ. Engrs. Discusses the design, manufacture, and erection of water pipes, siphons, culverts, and flumes, of varying cross section, constructed of mild steel. Ill. 5400 w. Prac Engr—Oct. 23, 1903. No. 58717 A.

Electric Plant.

The Electric Water Supply Plant of the City of Urfahr on the Danube (Wasserversorgung der Stadt Urfahr a. D. mit Elektrischem Betrieb). A. Oelwein. Describing the wells, reservoirs and electric pumping plant for the supply of a city of about 8,000 population. 3000 w. Zeitschr d Oesterr Ing u Arch Ver—Oct. 30, 1903. No. 59121 D.

Filtration.

A Remarkable Contract for Engineering Services and Water Filtration Patents. Abstract of the contract for the city of Wilmington, Del., with editorial comment. 2500 w. Eng News—Nov. 26, 1903. No. 59256.

A Small Open Sand Filter at Reading, Pa. Description, with illustrations, of the Egelman filter plant. 1600 w. Eng Rec—Nov. 7, 1903. No. 58844.

Filtration at Alexandria. An illustrated description of this plant in Egypt. 2500 w. Fire & Water—Nov. 21, 1903. No. 59067.

The Lawrence Filter. M. F. Collins. Illustrated description of the filter and its method of operation, and certain features of the results. 2500 w. Jour N Eng W Wks Assn—Sept., 1903. No. 59284 F.

Independent Supply.

The Water Supply of the Lackawanna Steel Works. Illustrates and describes a supply drawn directly from Lake Erie without filtration, to be used for industrial and mechanical purposes. May require daily from 70,000,000 to 75,000,000 gallons. 2400 w. Eng Rec—Nov. 21, 1903. No. 59205.

Irrigation.

Irrigation in South Africa. Discusses in detail the state control of rivers and other sources of supply, and the advantages gained by easily constructed devices for storing and distributing the natural flow. 5000 w. Engr, Lond—Nov. 13, 1903. No. 59079 A.

South African Irrigation. Augustine W. Wright. Continued discussion of paper by Francis Robert Johnson. 1600 w. Pro Am Soc of Civ Engrs—Oct., 1903. No. 58709 E.

Metric System.

The Folly of Reckoning by Gallons, Which Differ Widely in Canada and the United States, While All Countries Have Identical Liters and Cubic Meters. Frederick Brooks. Urging the use of metric system in measuring water consumed. 3300 w. Jour N Eng W Wks Assn—Sept., 1903. No. 59281 F.

Montreal.

History and Description of the Montreal Water Works. George Janin. A brief history and description of the aqueduct system. 3300 w. Ill. Jour N Eng W Wks Assn—Sept., 1903. No. 59282 F.

Service Boxes of the Montreal Water Works. T. W. Lesage. Illustrates and describes various types that have been tried, the difficulties due to climate and other conditions, and the present type. 1100 w. Jour N Eng W Wks Assn—Sept., 1903. No. 59283 F.

New York.

American Water Works. Charles Prelini. Gives a statement of conditions affecting the water supplies of America, reviewing briefly the general history of the water problem, with special reference to the Croton Aqueduct, and giving a detailed account of the actual state of the water supply of New York City. 5400 w. Trac & Trans—Nov., 1903. Serial. 1st part. No. 58898 E.

Pipes.

Care of Pipe and Conduits. James E. Maxwell. Calls attention to troubles due to the improper laying of pipes, and other conditions. 1500 w. Fire & Water—Nov. 14, 1903. No. 58934.

Reservoirs.

Amsterdam Reservoir Construction. Illustrated description of the new Glenwild storage reservoir belonging to the system of Amsterdam, N. Y. 2000 w. Fire & Water. Nov. 7, 1903. Serial. 1st part. No. 58785.

Covering an Old Reservoir at Brookline, Mass. F. I. Winslow. Describes the construction of a groined arch concrete roof. 800 w. Eng News—Nov. 12, 1903. No. 58977.

St. Louis.

Changes in the Settling Basins and the New Hydraulic Dredge of the St. Louis Water-Works. E. E. Wall. An illustrated account of interesting changes being made to substitute continuous sedimentation for the fill and draw method. 1300 w. Eng News—Nov. 26, 1903. No. 59259.

Statistics.

Water-Works Statistics for the Year 1902, in Form Adopted by the New England Water-Works Association. Compiled by Charles W. Sherman. 1500 w. Jour N Eng W Works Assn—Sept., 1903. No. 59280 F.

Wells.

The California or "Stove-Pipe" Method of Well Construction for Water Supply. Charles S. Slichter. Illustrated description of this type of well and method of construction. 2000 w. Eng News—Nov. 12, 1903. No. 58976.

MISCELLANY.

Engineering Principles.

The Borderland of Biology and Engineering: Exemplifications of Engineering Principles in Living Structures. Henry Leffmann. An interesting study. 2000 w. Pro Engrs' Club of Phila—Oct., 1903. No. 58704 D.

Landslide.

The Railway Landslide at Cleveland. An illustrated article describing the destruction of railways and buildings by a slide along the lake front. 1200 w. Eng Rec—Nov. 14, 1903. No. 58955.

Reclamation.

The United States Reclamation Service in the Arid West. F. H. Newell. A statement of the proposed work of reclaiming the arid lands and making possible their settlement. 1200 w. Eng News—Nov. 26, 1903. No. 59260.

ELECTRICAL ENGINEERING

COMMUNICATION.

Cable Laying.

Cable Laying in Manila and a Trip Around the World. Lewis G. Martin. An illustrated account of a trip to lay land cables for the Commercial Pacific Cable Co. 1800 w. Elec Rev, N Y—Nov. 14, 1903. No. 58949.

Cables.

Practical Examples with the Calculator Board. Edward Raymond-Barker. Notes for submarine cable staffs giving a series of practical examples worked out by use of the calculator board. 1400 w. Elec Rev, Lond—Oct. 23, 1903. Serial. 1st part. No. 58724 A.

Cable Steamer.

See Marine and Naval Engineering.

Longitude.

The Determination of the Longitude of Honolulu, 1555-1903. John F. Hayford. An account of the recent determination by the telegraphic method of the difference of longitude of San Francisco and Honolulu through the new Pacific Cable. 1700 w. Eng News—Nov. 5, 1903. No. 58866.

Printing Telegraph.

Steltje's Type-Printing Telegraph. Brief description, with illustration. No batteries are required, and the message is printed automatically at both ends of the line. 800 w. Sci Am—Nov. 7, 1903. No. 58886.

Secrecy.

Connections for Maintaining Secrecy in Communication (Schaltung zur Sicherung des Gesprächsgeheimnisses). J. E. Salzer. Describing methods of preventing private telephone communications from being overheard by exchange operators or others. 2500 w. Elektrotech Zeitschr—Oct. 22, 1903. No. 59140 B.

Space Telegraphy.

Some Wireless Telegraph Patents. Gives illustrated descriptions of recent patents granted in Great Britain. 2500 w. Elect'n, Lond—Nov. 6, 1903. Serial. 1st part. No. 58996 A.

The International Preliminary Conference to Formulate Regulations Governing Wireless Telegraphy. John I. Waterbury. Outlines the circumstances which led to this conference, and the work accomplished. 4500 w. N Am Rev—Nov., 1903. No. 58812 D.

The Relative Reliability of Wireless and Wire Telegraph Systems. Reginald A. Fessenden. Reports results of tests made during the past four years. 1500 w. Elec Wld & Engr—Nov. 14, 1903. No. 58971.

Wireless Telegraphy and Agriculture. Emile Guarini. An account of applications of wireless telegraphy being made in France. Ill. 1200 w. Elec, N Y—Nov. 4, 1903. No. 58920.

Telephony.

Municipal Telephones. J. F. Hemenway. Reports the successful operation in European and English cities at much lower rates than in America. 2800 w. Munic Jour & Engr—Nov., 1903. No. 58878 C.

Swansea Municipal Telephones. Outlines the history of this undertaking, giving details of the work. Ill. 800 w. Elec Engr, Lond—Nov. 13, 1903. No. 59090 A.

Transposition of Telephone Lines: Cross-Talk and Induction. Reviews a paper by Frank F. Fowle, read at the New Orleans meeting of the Assn. of Ry. Tel. Supts. on line disturbances arising from reactance and leakage. 2800 w. Elec Wld & Engr—Nov. 21, 1903. No. 59222.

Time Switch.

An Electric Time Switch (Ueber einen

Elektrischen Zeitschalter). Hans Carl Steidle. Describing a device for repeating any predetermined series of interruptions after a determinate time interval. 2500 w. Elektrotech Zeitschr—Oct. 15, 1903. No. 59137 B.

DISTRIBUTION.

Rotary Converters.

Some Notes on the Hunting of Rotary Converters. Clarence P. Fowler. Notes some of the most important causes, and means of preventing. 800 w. Am Elect'n—Nov., 1903. No. 58884.

Three-Phase.

Distribution of Current in Three-Phase Systems. F. Hardie Jeannin. Gives analysis of method of connecting up ammeters. 1400 w. Elec Wld & Engr—Nov. 14, 1903. No. 58969.

Three-Wire.

Notes on Certain Three-Wire Systems. Charles T. Mosman. Read before the Ohio Elec. Lgt. Assn. A discussion of the new conditions in electrical developments and points that should be considered. Thinks there is little justification for extensive use of the 500-volt three wire system in the United States. Considers desirable arrangements. 2000 w. Elec Rev, N Y—Oct. 31, 1903. No. 58768.

Transformers.

Construction of a Small Variable Voltage Transformer. W. B. Roberts. Illustrates a design having a maximum capacity of about 80 watts and capable of furnishing a secondary pressure from zero to about 5 volts. 2000 w. Am Elect'n—Nov. 5, 1903. No. 58883.

ELECTRO-CHEMISTRY.

Accumulators.

Development of the Light Accumulator Since 1900. H. L. Joly. Illustrates and describes types appearing since the date named, discussing tests made. 3600 w. Electro-Chem & Met—Oct., 1903. No. 59278 D.

Faure Type Accumulators. Abstract from a paper by M. Levazzari, read before the Second International Automobile Congress. Gives a résumé of storage battery conditions in France, limited to the light type of accumulators with pasted plates. 3500 w. Sci Am Sup—Nov. 14, 1903. No. 58985.

Antimony.

Electrolytic Process for Extracting Antimony from Its Sulphureted Ores. Translated from *La Revue des Produits Chimiques*. Describes the process, the object being to attract the antimony to one pole and the sulphur to the other. 1500 w. Sci Am Sup—Nov. 14, 1903. No. 58986.

Battery.

The Coal Battery. Hugo Jone. An illustrated description of an invention of the writer, which he claims will give more electrical energy than is obtainable by means of the dynamo, in combination with a steam, or gas engine. 4500 w. W Elect'n—Nov. 21, 1903. No. 59070.

Bleaching.

Electrical Bleaching (Elektrische Bleiche). A description of the Haas & Oettee process for the electrolytic production of bleaching solutions. 1800 w. Elektrochemische Zeitschr—Nov., 1903. No. 59151 G.

Carbon Bisulphide.

The Manufacture of Carbon Bisulphide in the Electric Furnace at Penn Yan, N.Y., U. S. A. Illustrates and describes the furnace used. 1000 w. Electro-Chem & Met—Oct., 1903. No. 59279 D.

Chloride Solutions.

Historical Sketch of the Development in the Production of Copper, Nickel, and Zinc from Chloride Solutions. William Koehler. Ill. 2000 w. Electro Chem Ind—Nov., 1903. Serial. 1st part. No. 58930 C.

Copper.

See Mining and Metallurgy.

Electrolysis.

The Present Position of the Theory of Electrolysis. Principally a discussion of the dissociation theory. 3300 w. Engng—Nov. 13, 1903. No. 59073 A.

Electro-Metallurgy.

Electro-Metallurgy in France. Illustrated article describing the works of the Société Electro-Metallurgique Française. 2500 w. Trac & Trans—Nov., 1903. No. 58901 E.

Experimental Studies.

Laboratory Notes for Students in Practical Electrochemistry. S. A. Tucker. Gives an account of experimental work at Columbia University. 3000 w. Sch of Mines Qr—July, 1903. No. 59293 D.

Ferro Metals.

A Brief Study of the Ferro Metals and Their Electrical Manufacture. Auguste J. Rossi. Describes the methods followed in the manufacture of ferro metals in general, and specially gives the results of four years study of ferro-titanium. 7000 w. Ir Age—Nov. 12, 1903. No. 58858.

Galvanizing.

The Galvanic Deposition of Zinc upon Iron (Galvanische Zinkniederschläge auf Eisen). O. Gabran. Giving data and results with various solutions at different current densities. 1800 w. Electrotech Zeitschr—Nov. 12, 1903. No. 59149 B.

Investigations.

The Behavior of Cerium, Lanthanum, Neodymium, Praseodymium, Thorium, and Zirconium Toward Organic Bases. Burt Laws Hartwell. A report of investigations made in the hope of finding an organic base that would lead to quantitative separations. 2500 w. Am Gas Lgt Jour—Nov. 23, 1903. No. 59213.

Water.

Apparatus for the Electrolysis of Water (Vorrichtungen zur Elektrolyse des Wassers). L. Tiersot. Describing the apparatus of Siemens & Halske for decomposing water on a large scale by the electric current. 1200 w. Elektrochemische Zeitschr —Nov., 1903. No. 59150 G.

ELECTRO-PHYSICS.

Conductivity.

Some Experiments on the Electrical Conductivity of Atmospheric Air. J. C. McLennan and E. F. Burton. Read before the Am. Phys. Soc. An account of experimental investigations, showing the effect of different metals and other influences. 2200 w. Sci Am Sup—Nov. 7, 1903. No. 58888.

The Electrical Conductivity of Commercial Copper. Lawrence Addicks. Considers the physical characteristics and their influence upon the conductivity; also the chemical impurities. 1500 w. Trans Am Inst of Elec Engrs—Nov. 20, 1903. No. 59300 D.

Discharges

Static Discharges in Electric Circuits. Percy H. Thomas. Considers the character of wave motion and the laws involved and treats by analogy the effects of waves in electric circuits. 3500 w. Jour Fr Inst —Nov., 1903. Serial. 1st part. No. 58913 D.

Electrodes.

Standard Electrodes. Woolsey McA. Johnson. Discusses the various standard electrodes from several points of view. 2500 w. Electro Chem Ind—Nov., 1903. No. 58929 C.

Electrostatics.

Notes on Electrostatics, Treated Opsigraphically. Hugh Erat Harrison. The present article is introductory and explanatory. 1700 w. Elec Times—Nov. 12, 1903. Serial. 1st part. No. 59068 A.

Indicator.

The Cathode Ray Alternating Current Wave Indicator. Harris J. Ryan. Describes a method of using the Braun type of cathode ray tube as an alternating current wave indicator. Discussion. Ill. 4500 w. Trans Am Inst of Elec Engrs—Oct., 1903. No. 59287 D.

Radio-Activity.

On the Intensely Penetrating Rays of Radium. R. J. Strutt. Communicated to the Royal Soc. A report of investigations. 600 w. Sci Am Sup—Nov. 7, 1903 No. 58890.

Radio-Activity. Edward A. Partridge and Robert H. Bradbury. Reviews the work of the Curies and other investigators, discussing the effects of emanations from radio-active bodies. 3500 w. Jour Fr Inst—Nov., 1903. No. 58911 D.

Radio-Activity. Frederick Soddy. The first of a series of articles based on lectures being delivered in London, to be revised and amplified and issued in book form. 3800 w. Elect'n, Lond—Oct. 23, 1903. Serial. 1st part. No. 58728 A.

Radium and Its Wonders. George F. Kunz. An interesting review of the history of this remarkable substance, its source, properties, action on organic bodies, value, etc. 6500 w. Rev of Revs—Nov., 1903. No. 58692 C.

GENERATING STATIONS.

Armature Cores.

The Factors Which Affect the Energy Losses in Armature Cores. J. Walter Esterline and C. E. Reid. An account of investigations with illustrated description of apparatus used. Also discussion. 6000 w. Trans Am Inst of Elec Engrs—Oct., 1903. No. 59285 D.

Commutators.

Commutator Brushes Running under Oil (Unter Oel Laufende Kommutatorbürsten). M. Osnos. Giving designs by use of which oil insulation may be used for commutators, with reduction of losses and avoidance of sparking. 1800 w. Zeit für Elektrotechnik—Oct. 11, 1903. No. 59155 D.

Compounding.

The Compounding of Alternators (Compoundierung von Wechselstrom-Generatoren). A. Heyland. Giving an application of the vector analysis to the problem of compounding with especial reference to the writer's improved system of synchronous compounding. 2500 w. Elektrotech Zeitschr—Nov. 5, 1903. No. 59145 B.

Copenhagen.

The Ostre Electric Station at Copenhagen (Das Ostre Elektricitätswerk in Kopenhagen). C. Hentzen. Illustrated description of a large generating station in the Danish capital. 3500 w. Elektrotech Zeitschr—Oct. 29, 1903. No. 59141 B.

Dynamo Design.

A Basis for the Comparison of Dynamo Designs. W. B. Esson. Critical remarks on an article by H. M. Hobart. 1100 w. Elect'n, Lond—Oct. 23, 1903. No. 58731 A.

Dynamos and Motors, Showing the Various Windings and Wire Connections. William H. Kritzer. Illustrated article describing the most important systems suitable for mining plants. 1400 w. Min & Sci Pr—Nov. 7, 1903. Serial. 1st part. No. 58946.

Formulas for the Design of Electrical Machinery (Formeln zum Entwerfen Elektrischer Maschinen). A Sengel. Deriving a number of convenient working formulas for use in designing dynamos, motors and transformers. 3000 w. Elektrotech Zeitschr—Oct. 29, 1903. No. 59142 B.

Some Practical Points in the Design of Direct-Current Dynamo-Electric Machines. Cecil P. Poole. Describes a plan of designing in the hope that it may be considered a slight advance on the practice usually followed. 3700 w. Jour Fr Inst—Nov., 1903. No. 58912 D.

Wiring Small Dynamos. An article in two parts, written for the guidance of the laymen. Ill. 3300 w. Aust Min Stand—Oct. 8 & 15, 1903. No. 58992 B.

Dublin.

Dublin Three-Phase Central Station. Illustrated description of an electric lighting system which employs the four-wire, three-phase distributing system. 2500 w. Elec Wld & Engr—Nov. 7, 1903. No. 58891.

Generating Set.

See Mechanical Engineering, Steam Engineering.

Generators.

Asynchronous Generators. A. S. McAllister. A discussion of the operation. 2200 w. Am Elect'n—Nov., 1903. No. 58881.

Gravesend.

Gravesend Borough Electricity Supply. B. Pontifex. An illustrated description of alterations and additions to an English plant. Low-tension continuous current is supplied on the three-wire system. 1600 w. Elec Engr, Lond—Nov. 6, 1903. No. 58997 A.

Hydro-Electric.

Central Power Station with Electric Distribution in Regions of Small Water Powers. F. A. C. Perrine. Abstract of a paper presented before the New England Cotton Mfrs.' Assn. On the wasteful and expensive development of power in New England, due to force of precedent and custom. Advocating transmission of power from a central plant. 1600 w. Eng News—Nov. 5, 1903. No. 58867.

The Chateaugay Water Power in the North Country. Illustrated description of a plant recently put in operation in northern New York. 500 w. Elec Wld & Engr—Nov. 21, 1903. No. 59219.

The Lachine Rapids Power House of the Lachine Rapids Hydraulic and Land Company, Limited, Montreal. R. S. Kelsch. The original and the present arrangement of generators, exciters, and switchboards, etc., are illustrated and described. 3300 w. Elec Rev, N Y—Nov. 21, 1903. No. 59207.

The Water Powers of British Columbia. E. Jacobs. A fully illustrated description of the hydro-electric stations supplying the mines, concentrating plants and cities of British Columbia. 3500 w. Engineering Magazine—Dec., 1903. No. 59162 B.

Isolated Plants.

The Systematized Operation of Isolated Plants. Percival Robert Moses. With forms and records for the organization and systematic operation of a moderate-sized electric station. 2500 w. Engineering Magazine—Dec., 1903. No. 59168 B.

Parallel Running.

Notes on the Theory of Parallel Running of Synchronous Machinery. H. C. Leake. A critical review of a paper entitled "The Parallel Working of Alternators," by Mr. B. Hopkinson. 3000 w. Elec Rev, Lond—Nov. 13 1903. No. 59087 A.

The Action of Dampers in the Parallel Running of Alternators (Die Wirkung des Dämpfers bei Parallel Arbeitenden Wechselstrommaschinen). E. Rosenberg. A discussion of the connection between damping and the reaction relation of the machines, showing that heavy flywheels obviate the necessity for damping. 7500 w. Elektrotech Zeitschr—Oct. 15, 1903. No. 59136 B.

Ryde.

The Ryde Electricity Works. Illustrates and describes the features of interest in this recently completed plant on the Isle of Wight, which circumstances limited to the least expensive type. 2500 w. Elect'n, Lond—Oct. 23, 1903. No. 58729 A.

Storage Batteries.

The Central Station Battery. R. W. Vicarey. Remarks on the care of batteries with suggestions. 1200 w. Elec Rev, Lond—Oct. 23, 1903. No. 58725 A.

The Comparative Behavior of Floating and Booster Controlled Batteries on Fluctuating Loads. Lamar Lyndon. Considers the five methods of installing a storage battery to maintain the load on the generator reasonably constant. 7000 w. Trans Am Inst of Elec Engrs—Nov. 20, 1903. No. 59301 D.

Switchboards.

The Care of Switchboards. Edwin W. Creed. An illustrated article calling attention to the care required. 2800 w. Power—Nov., 1903. No. 58832 C.

Westchester, N. Y.

Modernized District Central Station. Illustrated description of the power plant of the Bronx Gas & Electric Co., at Westchester, N. Y. 2200 w. Am Elect'n—Nov., 1903. No. 58880.

Willesden.

Recent Developments of the Metropolitan Electric Supply Co.'s Installations. Illustrated description of the progress made at Willesden, and in the sub-stations. 3000 w. Elec Rev, Lond—Nov. 13, 1903. Serial. 1st part. No. 59086 A.

LIGHTING.

Electricity v. Gas.

Some Points that Deter the Spread of Electric Lighting. F. H. Davies. Remarks on the slow progress of electric lighting in Great Britain, in competition with the use of gas, calling attention to some things that customers find annoying. 2500 w. Elec Engr, Lond—Nov. 13, 1903. No. 59091 A.

Europe.

Some Notes on the Commercial Features of European Lighting Practice. Abstract of a paper by Arthur Williams, read at the convention of the Assn. of Edison Ill. Co.'s. 2700 w. Elec Rev, N Y—Nov. 7, 1903. No. 58860.

Incandescent Lamps.

How Incandescent Lamps Are Made. E. Leavenworth Elliott. An outline of the processes and operations involved in the construction. 2500 w. Cent Sta—Nov., 1903. Serial. 1st part. No. 58914.

The Uses of Incandescent Lamps. Geo. T. Hanchett. Some of the principles by which great economies may be effected. 1800 w. Cent Sta—Nov., 1903. No. 58915.

MEASUREMENT.

Armature Inductance.

Calculation of the Apparent Inductance of Armature Coils. C. C. Hawkins. A résumé of the general principles of the calculation, supplement by a consideration of the effect of different windings. 2200 w. Elec Wld & Engr—Nov. 14, 1903. Serial. 1st part. No. 58970.

Electrometer.

An Unusual Form of Capillary Electrometer. Emilo Guarini. Illustrated description of an apparatus devised by S. W. T. Smith, of London. 600 w. Sci Am Sup—Nov. 14, 1903. No. 58987.

Frequency.

Measurement of the Frequency of Very Rapidly Alternating Currents. J. Wertheim Salomonson. An account of experimental investigations. 2000 w. Elect'n, Lond—Nov. 13, 1903. No. 59092 A.

Magnetic Units.

Magnetic Units and Other Subjects that Might Occupy Attention at the Next International Electrical Congress. A. E. Kennelly. Considers the C. G. S. system and the adapting it to practical requirements. Also discussion. 2500 w. Trans Am Inst of Elec Engrs—Oct., 1903. No. 59286 D.

Testing Alternators.

An Improved Method of Testing Large Alternators Under Full Load Conditions. B. A. Behrend. Also editorial. The magnetic balance is preserved by using different exciting currents for the motor section and for the generator section of the revolving field. 2000 w. Elec Wld & Engr—Oct. 31, 1903. No. 58770.

Units.

Theory of Units. Antonio Llano. Derives an easy and practical method for effecting the transformation from one system of units to another. Mathematical. 2500 w. Stevens Ind—Oct., 1903. No. 59296 D.

Wattmeters.

The Choice of Wattmeters. Paul MacGahan. On the importance of an accurate knowledge of the properties of a registering watt-hour meter. 1500 w. Elec Wld & Engr—Nov. 21, 1903. No. 59221.

Waves.

The Wave Measurer and Its Application (Der Wellenmesser und Seine Anwendung). J. Donitz. The instrument acts by the self-induction of a closed circuit in connection with a capacity and a hot wire indicator. 4000 w. Elektrotech Zeitschr—Nov. 5, 1903. No. 59146 B.

POWER APPLICATIONS.

Canal Haulage.

Electrical Equipment of the Miami Erie Canal. Charles W. Ricker. Illustrates and describes the equipment and plan of operation. Tows of eight or ten boats are to be hauled by a locomotive running on a track, using three-phase motors, and taking current from trolley wires at high voltage. Also editorial. 9500 w. St Ry Jour—Nov. 7, 1903. No. 58852 C.

Electric Towing on the Erie Canal. Brief illustrated description of a direct current aerial monorail system on trial at Schenectady. 1600 w. Elec Wld & Engr—Nov. 14, 1903. No. 58968.

Electric Traction on Canals. Reviews the various systems that have been tried, giving information in regard to the recent trials of the Wood system at Schenectady, and the system in operation on the Miami and Erie Canal. Ill. 2000 w. Eng Rec—Nov. 14, 1903. No. 58961.

Electric Driving.

Electricity in Manufacturing Plants. Walter M. McFarland. Considers briefly the older methods of power transmission and their disadvantages, contrasting them with the advantages of electric driving. Ills. 5500 w. Trans Am Soc Nav Archts & Marine Engrs, No. 10—Nov., 1903. No. 59046 D.

Requirements of Machine Tool Operation with Special Reference to the Motor Drive. Charles Day. Extracts from a paper presented before the N. Y. Elec. Soc. Discusses shop conditions, fixed charges, etc., in shops doing a general class of work. Ill. 4000 w. Ry & Engng Rev—Nov. 21, 1903. No. 59237.

Glass.

Electricity in Glass Manufacture. An illustrated detailed account of experimental works, describing the furnaces that have been patented. 2000 w. Engr, Lond—Oct. 23, 1903. No. 58736 A.

The Use of Electricity for Glass Manufacture. John B. C. Kershaw. Gives the details of construction of electric glass furnaces, with all the information available relating to the two experimental works in operation. Ill. 2200 w. Elec Rev, N Y—Nov. 21, 1903. No. 59208.

Government Service.

Electricity in the United States Government Service. J. E. Price. An illustrated article giving an interesting account of the uses, especially the distribution of correct time for public clock service, the registering of earthquake shocks, and the business of the magnetic observatory. 1300 w. Elec Rev, N Y—Oct. 31, 1903. No. 58766.

Induction Motor.

The Choice of Rotor Diameter for Induction Motors (Die Wahl des Rotordurchmessers bei Induktionsmotoren). H. M. Hobart. A discussion of the formula of Behrend with application to a practical example. 1800 w. Elektrotech Zeitschr—Nov. 12, 1903. No. 59147 B.

The Heyland Induction Motor. A. S. Langedorf. An illustrated description of the motor and its theory of operation, its advantages and disadvantages. 2500 w. Jour Assn of Engng Socs—Sept., 1903. No. 59271 C.

Mining.

Electrical Mining Notes. Sydney F. Walker. Reviews the excursions of Inst. of Min. Engrs., of England, to Sherwood and Glapwell collieries, describing their electric plants. 1400 w. Elec Rev, N Y—Nov. 14, 1903. Serial. 1st part. No. 58950.

Some Electric Mining Appliances. Illustrations with brief descriptions of hauling engines, pumps, etc., designed and constructed by the Union Elektricitäts Gesellschaft. 1500 w. Engr, Lond—Nov. 13, 1903. No. 59080 A.

Pumping Plant.

Electric Pumping Plant for De Beers Consolidated Mines, Kimberley. Illustrated description. 900 w. Elec Rev, Lond—Nov. 13, 1903. No. 59085 A.

See Civil Engineering, Water Supply.

Repulsion Motor.

The Circle Diagram of the Repulsion Motor (Das Kreisdiagramm des Repulsions-motors). M. Osnos. A discussion of the application of the vector analysis to the solution of problems of speed and torque in repulsion motors; graphical and analytical treatments are given. 4000 w. Elektrotech Zeitschr—Oct. 29, 1903. No. 59143 B.

Series Motor.

The Theory of the Compensated Series Motor (Theorie des Kompensierten Serienmotors). M. Osnos. An application of the vector analysis to the solution of problems relating to the compensated motor; graphical and analytical examples are given. 3000 w. Elektrotech Zeitschr—Nov. 12, 1903. No. 59148 B.

Single Phase.

Single-Phase Motors without Difference of Phase (Einphasenmotoren ohne Phasenverschiebung). Marius Latour. Describing the simple form of single-phase repulsion motor designed by the writer, with a mathematical discussion showing the torque at different speeds. 2000 w. Elektrotech Zeitschr—Oct. 22, 1903. No. 59138 B.

Three-Phase.

The Speed Regulation of Three-Phase Motors. Abstract translation of an article by W. Burkard in *Elektrotechnische Zeitschrift*. An illustrated explanation of the principal methods. 900 w. Elec Engr, Lond—Nov. 13, 1903. No. 59088 A.

TRANSMISSION.

Cables.

Losses in High Pressure Cables (Arbeitsverluste in Hochspannungskabeln). Dr. R. Apt and C. Mauritius. Data and results of tests of dielectric losses in transmission cables operated at pressures of 20,000 to 30,000 volts. 5000 w. Elektrotech Zeitschr—Oct. 22, 1903. No. 59139 B.

Fuses.

Fuses and Circuit Breakers in Transmission Lines. Alton D. Adams. Explains the primary object, and the qualities of each, discussing the variation in practice. 1800 w. St Ry Rev—Nov. 20, 1903. No. 59244 C.

Switches.

Oil-Break Switches and Fuses. Discusses the advantages of oil-break switches for alternating currents of high potentials, their design, etc., and gives a summary of the best developments of switchboard design. 4500 w. Elec Engr, Lond—Oct. 30, 1903. No. 58793 A.

Transmission Lines.

The Graphical Computation of Power Transmission Lines with Converters (Graphische Berechnung von Kraftübertragungslinien mit Umformern). A. Hruschka. Developing graphical diagrams for computing the various elements of a power transmission line operated by a main station in connection with converter stations. Two articles. 3500 w. Zeit für Elektrotechnik—Oct. 11, 1903. No. 59154. Each D.

MISCELLANY.

Cells.

A Method of Milking Faulty Cells. W. Dalton. Briefly describes method, giving diagram showing the connections. 500 w. Elec Engr, Lond—Oct. 23, 1903. No. 58723 A.

Electrical Problems.

The Problems That Are Facing the Electrical Engineer of To-Day and the Qualities of Mind and Character Which Are Needed to Meet Them. J. G. White. A discussion of this subject. 4500 w. Trans Am Inst of Elec Engrs—Oct., 1903. No. 59289 D.

Germany.

German Electrical Industries. Editorial review of the wonderful rise and collapse of these industries in Germany, the cause and the outlook. 3300 w. Engng—Oct. 23, 1903. No. 58735 A.

Spain.

Electrotechnics in Spain (Die Elektrotechnik in Spanien). D. Blumenthal. A general account of the development of electrical industries in Spain, and the present opening there for a market in electrical appliances. 3000 w. Elektrotech Zeitschr—Nov. 5, 1903. No. 59144 B.

Statistics.

Some Statistics Relating to Electrical Engineering. William Pollard Digby. Gives figures showing the import and export trade of the United Kingdom in electrical goods, and compares with the internal trade. 1400 w. Elect'n, Lond—Nov. 6, 1903. Serial. 1st part. No. 58995 A.

GAS WORKS ENGINEERING

Air Gas.

Air Gas. Describes methods of preparing carburetted air, its properties, defects, etc. 2800 w. Engr, Lond—Nov. 6, 1903. No. 59008 A.

Barracks.

Directions for the Lighting of French Barracks. Abstract translation of the portion relating to gas lighting, as given in a document of the Department of the French Military Administration. 2800 w. Jour Gas Lgt—Nov. 3, 1903. No. 58910 A.

Bunsen Burners.

Professor Smithells on the Bunsen Burner. Sketch of an interesting lecture, recording the results of important experimental work. 3500 w. Jour Gas Lgt—Nov. 3, 1903. No. 58909 A.

Enrichment.

The Low Candle-Power Policy and Its Critic. Editorial review of a paper on "The Policy of Gas Enrichment," by A. G. Glasgow, read before the Am. Gas Lgt. Assn. 1500 w. Gas Wld—Oct. 31, 1903. No. 58792 A.

The Policy of Gas Enrichment (Illustrated by London Practice.) Arthur Graham Glasgow. Read at the Detroit meeting of the Am. Gas Lgt. Assn. A discussion of the advantages of gas enrichment, explaining methods, especially the enrichment by carburetted water gas. 9000 w. Am Gas Lgt Jour—Nov. 9, 1903. No. 58814.

Gaseous Fuel.

A Consideration of the Gaseous Fuel Problem. Henry G. Morris. Reviews briefly the history of the use of gas as an illuminant and for fuel. Discussion. 4500 w. Pro Engrs' Club of Phila—Oct., 1903. No. 58703 D.

Gas Referees.

The Arraignment of Gas Refereeism. C. E. Jones. Discussion of some aspects of refereeism as applied to gas affairs in England. 4000 w. Jour Gas Lgt—Oct. 27, 1903. No. 58790 A.

High Pressures.

Gas Distribution at High Pressures. Reviews the paper by John A. Britton, read before the Pacific Coast Gas Assn. with critical remarks. 2000 w. Jour Gas Lgt—Oct. 27, 1903. No. 58789 A.

Improvements.

Enlargements and Improvements at the Stafford Corporation Gas Works. An illustrated account of changes during the last few years. 3800 w. Jour Gas Lgt—Nov. 3, 1903. No. 58908 A.

Leakage.

An Apparatus for Measuring Gas Leakage. Emil Guarini. Illustrated description of a portable gasometer used in Paris, and the method. 1000 w. Eng News—Nov. 26, 1903. No. 59258.

Mond Process.

Power Gas. Harold Medway Martin. Points out the differences between producer gas and ordinary coal gas, describes the Mond process and the uses to which it has been applied, giving illustrated descriptions of five plants in England. 6500 w. Trac & Trans—Nov., 1903. No. 58897 E.

Municipal Ownership.

Some Features of Municipal Ownership. Henry L. Doherty. Read before the Am. Gas Lgt. Assn. A consideration of questions in regard to municipal ownership, discussing the reasons offered to justify it. 8400 w. Am Gas Lgt Jour—Nov. 2, 1903. No. 58744.

Natural Gas.

Natural Gas in Steam Production. W. R. Crane. Illustrates and describes methods employed in the Kansas gas fields with a comparison of the fuel value of gas with that of coal. 3500 w. Mines & Min—Nov., 1903. No. 58739 C.

Producers.

Anthracite Gas Producers for Power Purposes. Reviews the development in this field, illustrating and describing a number of producers. 3500 w. Ir & Coal Trds Rev—Oct. 30, 1903. Serial. 1st part. No. 59072 A.

Purifying.

Simplified Method for Purifying Gas with a View to Complete Recovery of Tar and Ammonia. Summary of a paper read before the German Gas Assn. Describes a method of saturating the gas with steam. Ill. 600 w. Gas Wld—Oct. 24, 1903. No. 58715 A.

Retorts.

Notes on the Construction of Inclined Retort Settings. Archd. S. B. Little. On the designing of inclined retort settings, and present practice. Ill. 3300 w. Jour Gas Lgt—Oct. 20, 1903. Serial. 1st part. No. 58711 A.

Transmission.

Gas-Pipe v. Copper. C. Alfred Smith. Outlines a scheme for the generation and transmission of power gas, comparing costs, and discussing details. 2000 w. Elec Rev, Lond—Oct. 30, 1903. No. 58794 A.

Troubles.

Other Troubles Than Naphthalene: An Invitation for Discussion. John Terrace. Read before the So. District Assn. of Gas Engrs. & Mgrs. Considers the thick tar trouble, tar in the oxide, and other troubles. Discussion. 6000 w. Gas Wld—Nov. 14, 1903. No. 59094 A.

Water Gas.

Economic Advantages of Working a Carburetted Water-Gas Plant in Conjunction with Coal-Gas Plant. S. Carpenter. Read before the So. Dist. Assn. of Gas Engrs. & Mgrs. Considers the convenience, cost, coke factor, advantages, etc. Discussion. 8200 w. Gas Wld—Nov. 14, 1903. No. 59093 A.

Notes on the Operation of Large Carburetted Water Gas Sets. W. Cullen Morris. Read before the Am. Gas Lgt. Assn. Reviews the work of other investigators and gives data accumulated with the idea of determining the proper rate of flow of steam supply to the generators for producing the best working results, and the economy of new sets introduced. 3000 w. Am Gas Lgt Jour—Nov. 2, 1903. No. 58745.

Welsbach.

Candle-Power Tests of Welsbach Burners. Abstract of the fourth progress report of the N. E. L. A. Committee for Investigating the Photometric Value of Arc Lamps, which deals with tests of mantle gas burners and of the naked gas flame. 800 w. Elec Wld & Engr—Oct. 31, 1903. No. 58771.

INDUSTRIAL ECONOMY

Apprentices.

Apprenticeship. Robert Patterson. A paper read before the Canadian Railway Club, describing the excellent system of training apprentices in use at the shops of the Grand Trunk Railway. 2500 w. R R Gaz—Oct. 2, 1903. No. 58769.

The Training of Apprentices in Engineering Works. C. E. Downton. A description of the system and methods of training apprentices in the works of the Westinghouse Electric and Manufacturing Co. 3500 w. Engineering Magazine—Dec., 1903. No. 59165 B.

Coal Production.

See Mining and Metallurgy, Coal and Coke.

Day Labor.

Municipal vs. Contract Construction. James M. Head. Claims advantages of "day labor systems" over contract work, illustrating by results. 3800 w. Munic Jour & Engr—Nov., 1903. Serial. 1st part. No. 58879 C.

Economy.

Experience, Theory and Practice. Robert H. Smith. Discusses the proper standards of economical outlay. 4200 w. Engr, Lond—Oct. 30, 1903. No. 58804 A.

Education.

Industrial Education in Europe. Reviews progress made in Italy, Holland, Russia, Sweden, Norway, Switzerland, Austria, and France. 3000 w. U S Cons Repts—Nov., 1903. No. 58811 D.

Mining Instruction in Germany. Particulars relating to the courses in mining at various educational institutions in Germany, extracted from report by Dr. Frederick Rose. 2500 w. Col Guard—Oct. 30, 1903. No. 58796 A.

The Proper Qualifications of Electrical Engineering School Graduates from the Telephone Engineer's Standpoint. Bancroft Gherardi, Jr. Discusses education with reference to the providing the necessary qualifications needed in this work. 3500 w. Trans Am Inst of Elec Engrs—Oct, 1903. No. 59290 D.

The Typical College Courses Dealing with the Professional and Theoretical phase of Electrical Engineering. Dugald C. Jackson. Shows the wide variance between the methods of the colleges and discusses the essentials preparatory to professional studies, the courses, etc. 4000 w. Trans Am Inst of Elec Engrs—Oct, 1903. No. 59291 D.

Labor.

An Opportunity for the Building Trade Unions. Editorial discussion of existing conditions in the building trade with suggestions for a remedy. 1800 w. Ir Age—Nov. 26, 1903. No. 59251.

Is Organized Labor Right? The Only Question. David M. Parry. Discusses the "closed shop," wages, &c. Also considers attitude of employers' associations. 2500 w. Bankers' Mag, N Y—Nov., 1903. No. 58944 D.

The Labor Problem. From the annual address of Pres. I. E. Knisely before the Ohio Bankers' Assn. The relations of labor and capital are briefly discussed. 01000 w. Bankers' Mag, N Y—Nov., 1903. No. 58945 D.

Mosely Commission.

Mr. Mosely's Industrial Inquiry. Translated from a paper published by the Union of Metal and Mine Workers of France. Discussion of the first commission's visit to the United States. 4500 w. U S Cons Repts—Nov., 1903. No. 58810 D.

Oil.

The Oil Industry of California from a Commercial Standpoint. Dr. Deane. Information concerning the oil deposits, methods of well sinking, production, consumption, &c. 8000 w. Jour of Elec—Nov., 1903. No. 58926 C.

Strike.

Chicago Street Railway Strike. An account of the methods of obstructing tracks adopted by the union and its sympathizers, and of the troubles and attitude of those in authority. Ill. 1800 w. St Ry Jour—Nov. 21, 1903. No. 59212 C.

Works Management.

Manufacturing: Capital, Costs, Profits and Dividends. Henry Hess. Developing an improved graphical method of analyzing and interpreting cost accounts and works records. An important paper. 3500 w. Engineering Magazine—Dec., 1903. No. 59164 B.

MARINE AND NAVAL ENGINEERING

Address.

Presidential Address before the Institution of Civil Engineers. Abstract of the address of Sir William Henry White, on naval and mercantile marine matters in Great Britain. A review of progress during forty-four years. 5000 w. Engng—Nov. 6, 1903. Serial. 1st part. No. 59006 A.

Boilers.

German Marine Boiler Construction. Frank C. Perkins. Illustrations, with description of the making of the Dürr water-tube marine boilers. 1700 w. Sci Am Sup—Nov. 14, 1903. No. 58984.

Cable Steamer.

The Twin-Screw Cable Steamer "Stephan" (Der Doppelschrauben-Kabeldampfer "Stephan"). H. Hildebrandt. Illustrated description of the new steamer constructed for use in laying the second

German trans-Atlantic cable. 3000 w. 2 plates. Zeitschr d Ver Deutscher Ing—Oct. 31, 1903. No. 59104 D.

Evaporators.

Evaporators and Distillers. W. W. Edwards. Modern means of securing fresh water at sea. Various types are illustrated and described. 5300 w. Marine Engng—Nov., 1903. No. 58828 C.

Ferry-Boats.

Progressive Trials of Ferry-Boat Bremen. Col. Edwin A. Stevens. Gives results of the analysis of the trials. 1400 w. Trans Am Soc Nav Archts & Marine Engrs, No. 1.—Nov., 1903. No. 59038 D.

The Steam Ferry over the North Sea Canal at Velzen (De Stoomponten voor het veer over het Noordzee kanaal te Velzen). C. Kloos. Illustrating a chain tow ferry system across the North Sea Canal in Holland. 1000 w. De Ingenieur—Oct. 24, 1903. No. 59152 D.

Gasoline Engines.

Gasoline Engines for Marine Propulsion. D. H. Cox. Presents facts showing progress and development of these engines, drawing conclusions therefrom. Ills. 6000 w. Trans Am Soc Nav Archts & Marine Engrs, No 4—Nov., 1903. No. 59040 D.

Petroleum Motors on Fishing Boats (Les Moteurs à Pétrole à Bord des Voiliers de Pêche). C. Birault. Describing the installation of small internal-combustion motors as auxiliaries on sailing vessels. 2500 w. Génie Civil—Oct. 31, 1903. No. 59113 D.

German Navy.

The Imperial German Navy. Archibald S. Hurd. Reviews the recent naval expansion, giving illustrations. 3000 w. Cassier's Mag—Nov., 1903. No. 58892 B.

German Steamer.

The German Lake Steamer Stadt Meersburg. Translated from *Zeitschrift des Vereins Deutscher Ingenicure.* Illustrated description of a paddle wheel steamer recently placed on Lake Constance to connect the railways of the German shore with the Swiss cities on the lake. 2000 w. Naut Gaz—Nov. 5, 1903. No. 58816.

Launch.

Coaching Steam Launch Moguntia with Petroleum Fuel. Translated from *Zeitschrift des Mitteleuropäischen Motorwagen Verein.* An illustrated account of a high-speed pleasure launch. 1400 w. Marine Engng—Nov., 1903. No. 58829 C.

Launching.

Launching of Large Merchant Vessels. William A. Fairburn. Considers the statistics and dynamics of stern launching, giving data of merchant vessels. 6500 w. Trans Am Soc Nav Archts & Marine Engrs. No. 16—Nov., 1903. No. 59052 D.

Notes on Launching of the Cruiser Chattanooga. Mason S. Chace. An account of the method employed to check and stop the ship before she had moved more than 283 ft. Ill. 2500 w. Trans Am Soc Nav Archts & Marine Engrs, No. 14—Nov., 1903. No. 59050 D.

Notes on Side Launchings. William G. Groesbeck. Describes the side launching of the cruiser Galveston and the suction dredge Benyuard. 1500 w. Trans Am Soc Nav Archts & Marine Engrs, No. 15—Nov., 1903. No. 59051 D.

Metric System.

The Metric System in Relation to the Shipbuilding Industry of the United States. J. H. Linnard. Considers the effect of introducing the metric system in its application to the shipbuilding and marine engine industry, not favorable to its adoption. 4700 w. Trans Am Soc Nav Archts & Marine Engrs, No. 9—Nov., 1903. No. 59045 D.

Motor Boat.

Long Trial Trip with Fast Motor Boat. Describes a trip from Rhode Island to Michigan in a sixty-foot motor boat of 80 h. p. in two engines. 1000 w. Automobile—Oct. 31, 1903. No. 58748.

Oil-Motor Boat for the Uganda Railway Company. Illustrated description of a boat to be used on Lake Victoria. 1400 w. Engng—Nov. 6, 1903. No. 59004 A.

Ship Curves.

Curves of Form of the Initial Condition. George Crouse Cook. A simple method of calculating and recording (by curves) the data of form useful in designing vessels. 10500 w. Trans Am Soc Nav Archts & Marine Engrs, No. 8—Nov., 1903. No. 59044 E.

On Ships' Forms Derived by Formulae. D. W. Taylor. Derives formulae for waterlines, sections, &c., explaining their value in the designing of vessels. Tables, diagrams, &c. 6000 w. Trans Am Soc Nav Archts & Marine Engrs, No. 12—Nov., 1903. No. 59048 D.

Stability.

A Graphic Method for the Calculation of the Stability of Ships. M. H. Bauer. Explains this method in detail. 3500 w. Trans Am Soc Nav Archts & Marine Engrs— Nov. 18, 1903. No. 59054 D.

Displacement and Stability Calculations by Improved Methods. Prof. W. S. Leland. Explains forms arranged for classroom use, in the hope they may be of practical use. 2000 w. Trans Am Soc Nav Archts & Marine Engrs, No. 17—Nov., 1903. No. 59053 D.

Steamships.

Description of the Design and Building of the 21,000-Ton Steamships Minnesota and Dakota. Charles R. Hanscom. Describes the yard and equipment and the difficult problems encountered. Fully illustrated. 13600 w. Trans Am Soc Nav Archts & Marine Engrs, No. 11—Nov, 1903. No. 59047 F.

Mallory Line Twin Screw Passenger and Freight Steamship San Jacinto. Illustrated detailed description of a new vessel for service between New York and Galveston, Tex. 5400 w. Marine Engng—Nov., 1903. No. 58825 C.

The Boston Steamer Old Colony. An illustrated description of a new excursion boat for service in Boston harbor. 1200 w. Naut Gaz—Nov. 19, 1903. No. 59234.

The Steamship Yongala. Illustrates and describes a vessel designed for the Australian coasting and passenger trade. 900 w. Eng, Lond—Oct. 30, 1903. No. 58807 A.

Submarine.

The Success of the Submarine. Archibald S. Hurd. Discusses the British and French submarines, and their value as instruments of warfare. 4500 w. Nineteenth Cent—Nov., 1903. No. 59033 D.

Torpedo Vessels.

Some Notes on the Performance of the Torpedo Vessels of the United States Navy at Sea. Lieut. L. H. Chandler. Tables of information with explanatory notes. 2000 w. Trans Am Soc Nav Archts & Marine Engrs, No. 13—Nov., 1903. No. 59049 D.

Warships.

Water-Tight Subdivision of Warships. Com. William Hoogaard. A study of the principles which underlie the application of water-tight subdivision in warships. 11700 w. Trans Am Soc Nav Archts & Marine Engrs., No. 6—Nov., 1903. No. 59042 E.

Water-Tightness.

Methods of Securing Water-Tightness of plates at Conduit and Tubes. George McQuilkin, Jr. Illustrates and describes types in use, especially in the care of water-tight bulkheads, and recommends standardization. 3300 w. Marine Engng —Nov., 1903. No. 58826 C.

Yachts.

Some Thoughts on the Design of Modern Steam Yachts. Clinton H. Crane. Gives plans of the steam yacht Noma, built by the Burlee Dry Dock Co., of Staten Is., as an example of modern design. Ills. 1000 w. Trans Am Soc Nav Archts & Marine Engrs, No. 5—Nov., 1903. No. 59041 D.

MECHANICAL ENGINEERING

AUTOMOBILES.

Accumulators.

Electric Automobile Accumulator Cells for Quick Charge Rates. E. Kilburn Scott. Remarks on the Elieson plate cell, and a solidly-built cell designed by Mr. Niblett, in which the buckling trouble is done away with. 1400 w. Elec Engr, Lond—Nov. 13, 1903. No. 59089 A.

Electric Carriages.

Electric Automobiles. H. F. Joel. Abstract of a paper read before the Inst of Civ. Engrs., England. Reviews this industry, and the progress made, giving information of interest. 2000 w. Sci Am Sup—Nov. 7, 1903. No. 58887.

Hill Climb.

Gaillon Hill Climb. An illustrated description of this recent test. 1200 w. Auto Jour—Nov. 14, 1903. No. 59097 A.

Internal Combustion.

Governing Gas and Petrol Engines. Dugald Clerk. Excerpts from a paper read at meeting of the Automobile Club, London. Briefly considers methods that have been and are in use. 1500 w. Auto Jour—Oct. 31, 1903. No. 58788 A.

Knox Car.

Description of the Two-Cylinder Knox Car. Herbert L. Towle. Detailed account with illustrations. 3800 w. Automobile—Nov. 7, 1903. No. 58815.

Korte Car.

The 14 H. P. Two-Cylinder Korte Car. Drawings and description. 2000 w. Autocar—Oct. 24, 1903. No. 58714 A.

Light Car.

The 5 H. P. Vauxhall Light Car. Illustrated description of a light car propelled by mechanism of the simplest character, and easily controlled. 1800 w. Autocar—Oct. 31, 1903. No. 58787 A.

Motors.

Evolution of Light High-Speed Motors. Herbert L. Towle. An explanation of the principles of design entering into the manufacture of motors intended for automobiles of high first cost. 3000 w. Automobile—Nov. 21, 1903. Serial. 1st part. No. 59238.

Napier.

The 1904 Napier Model. Brief description of some of the novel features. Ill.

1200 w. Auto Jour—Oct. 24, 1903. No. 58713 A.

Omnibuses.

Motor Omnibuses in Great Britain. Martha L. Root. Illustrates the vehicles being put in service in London, and gives information of other systems. 1700 w. Automobile—Nov. 14, 1903. No. 58935.

Petrol Cars.

The Dennis Petrol Motor Cars. Begins an illustrated detailed description of these cars. 700 w. Prac Engr—Oct. 23, 1903. Serial. 1st part. No. 58716 A.

Racing.

Skidding on the Race Track Analyzed. Showing the importance of the driver's position. 1100 w. Automobile—Nov. 14, 1903. No. 58937.

Steam Cars.

The Cremorne Steam Cars and Automobile Parts. Begins an illustrated detailed description. 1800 w. Auto Jour—Nov. 14, 1903. Serial. 1st part. No. 59096 A.

Steam Van.

Waring's "Gillett" Motor Van. Illustrates and describes a steam delivery van. 2000 w. Auto Jour—Nov. 7, 1903. No. 58991 A.

Tires.

A New Motor Tyre. An illustrated description of the new Palmer tyre. 2000 w. Autocar—Nov. 14, 1903. No. 59098 A.

A Study of the Failure of Automobile Tires (Etude du Dérapage des Automobiles). J. Résal. An examination of the forces acting upon an automobile, with especial reference to the stresses tending to strip the pneumatic tires from the wheels. Two articles. 4000 w. Génie Civil—Oct 17, 24, 1903. No. 59109 each D.

Traction Experiments.

The Resistance of Road Vehicles to Traction. Abstract of a report of a committee of the British Assn. 3000 w. Elect'n, Lond—Oct. 23, 1903. No. 58730 A.

Tractors.

Power-Steered Electric Tractors for Commercial Vehicles. Illustrated description of a mechanism patented in Italy and soon to be put on the market in the United States. 600 w. Automobile—Oct. 31, 1903. No. 58747.

Trials.

Industrial Car Trials in Paris. Remarks on these trials, the few vehicles entered, and lack of interest. 1600 w. Engr, Lond—Nov. 6, 1903. No. 59009 A.

Wheels.

The Wheels for Automobiles. Extract from a paper read by Commandant Ferrus at the Paris International Automobile Congress. Gives some points in regard to the manufacture of wheels. 800 w. Automobile—Nov. 14, 1903. No. 58936.

HYDRAULICS.

Air Lift.

Raising Water by Compressed Air. William H. Maxwell. Read before the British Assn. of Water-Works Engrs. Gives the working results of a plant on the "air-lift" system at Tunbridge Wells, with a general review of the conditions under which the system may be successfully applied. 3500 w. Engng—Nov. 13, 1903. No. 59078 A.

Centrifugal Pumps.

Fans and Centrifugal Pumps for High Pressures Driven by Steam Turbines or Electro-Motors. Summary of a paper by Prof. A. Rateau, in the *Bulletin de la Société de l'Industrie Minerale*. Ill. 2300 w. Prac Engr—Nov. 6, 1903. Serial. 1st part. No. 58994 A.

Theory of Centrifugal Pumps and Fans: Analysis of Their Action, with Suggestions for Designs. Continued discussion on paper by Elmo G. Harris. 7200 w. Pro Am Soc of Civ Engrs—Oct., 1903. No. 58708 E.

Electric Pumps.

See Civil Engineering, Water Supply.

See Electrical Engineering, Power Applications.

Flow.

An Experimental Study of the Resistances to the Flow of Water in Pipes. E. G. Coker and George W. Fenkell. Continued discussion of paper by Augustus W. Saph and Ernest W. Schoder. 1200 w. Pro Am Soc of Civ Engrs—Oct., 1903. No. 58707 E.

Hydraulic Engine.

Hydraulic Driven Pumping Plant (Hydraulisch Betriebene Wasserhaltungsanlage). H. Unger. A detailed description of direct-acting hydraulic engines driving drainage pump at the Altendorf Mine at Dahlhausen on the Ruhr. 2000 w. 2 plates. Glasers Annalen—Nov. 1, 1903. No. 59129 D.

Hydro-Electro Plants.

See Electrical Engineering, Generating Stations.

Niagara.

Hydraulic Features of the Plant of the Niagara Falls Power Company. The present article reviews the general considerations, describing the canal and intakes. Ill. 4000 w. Eng Rec—Nov. 21, 1903. Serial. 1st part. No. 59201.

Pumps.

A History of Pumps, Ancient and Modern. John A. Drew. A lecture delivered before the Brooklyn's Engrs.' Club. Historical review with illustrations. 6000 w. Engr, U S A—Nov. 16, 1903. No. 59020 C.

Water Power.

The Utilization of Waterfalls (Utilisation des Chutes d'Eau). F. Loppé. A review of the work of the Congrès de la Houille Blanche, with regard to the development of the water powers of France. 2000 w. Revue Technique—Oct. 25, 1903. No. 59116 D.

MACHINE WORKS AND FOUNDRIES.

Annealing.

Annealing. E. R. Markham. Suggestions for properly heating and cooling to obtain success. 1000 w. Am Mach—Nov. 5, 1903. No. 58824.

Blast Furnaces.

See Mining and Metallurgy, Iron and Steel.

Blow Holes.

See Mining and Metallurgy, Iron and Steel.

Boring.

Aligning and Boring Large Engine Frames. Illustrates and describes the methods used by a firm in Providence, R. I. 500 w. Am Mach—Nov. 5, 1903. No. 58821.

Castings.

Pickling Castings. Some points on methods in use, the acids and the dangers accompanying their use. 1200 w. Foundry—Nov., 1903. No. 58696.

Cores.

Cores for Aluminium Castings. Walter J. May. Reports satisfactory results with cores made of asbestic coated with steatite. 700 w. Prac Engr—Oct. 30, 1903. No. 58693 A.

Cranes.

Gantry Crane of the Buffalo Dry-Dock Company. Illustrated description of a large cantilever crane for handling material. 900 w. Marine Engng—Nov., 1903. No. 58827 C.

Die-Forging.

Hammers Used in Die-Forging. Illustrates and describes types of hammers used largely in the work of die-forging. A supplementary article to a recently published series. 1600 w. Engng—Nov. 6, 1903. Serial. 1st part. No. 59003 A.

Drawing Instrument.

Tooth Curve Drawing Instrument. Franz Hass. Translated and abridged from the *Zeitschrift des Vereines Deutscher Ingenieure*. Illustrated description of the method and instrument. 1100 w. Am Mach—Nov. 19, 1903. No. 59016.

Drawings.

A Filing and Indexing System for Drawings. E. C. de Wolfe. Describes the system used by the Dodge Mfg. Co., at Mishawaka, Ind. 3000 k. Am Mach—Nov. 12, 1903. Serial. 1st part. No. 58933.

Electric Power.

See Electrical Engineering, Power Applications.

Foundry Plant.

An Interesting Study of Foundry Development. Illustrated description of a foundry in Newark, N. J., where electric motors tend to economy in the handling of raw materials and castings. 2500 w. Elec Rev, N Y—Oct. 31, 1903. No. 58767.

Foundry Plant of Maher & Flockhart at Newark, N. J. Illustrated description of works which have been gradually enlarged to meet the requirements. 2500 w. Foundry, Nov., 1903. No. 58697.

The Foundry and Town of Trafford City, Pa. An illustrated article giving information concerning this extensive plant. 3500 w. Eng Rec—Oct. 31, 1903. No. 58760.

Foundry Iron.

Blast Furnace Conditions and the Composition of Foundry Iron. W. Walley Davis. Read before the Am. Found. Assn. Discusses the important points in the manufacture of foundry iron. 3000 w. Foundry—Nov., 1903. No. 58701.

Economy in Buying, Mixing and Melting Iron. Herbert E. Field. Read at meeting of Pittsburg Found. Assn. Discusses points of importance in methods the writer considers most economical. 5500 w. Ir Trd Rev—Nov. 12, 1903. No. 58939.

Frames.

Design of Punch and Riveter Frames. John S. Myers. Describes method of making necessary calculations, illustrating by example. 2000 w. Mach, N Y—Nov., 1903. No. 58757 C.

Governors.

Treatment of Shaft Spring Governors. Hubert E. Collins. Considers the difficulties that may occur in the handling of a shaft-governor, with the remedies, giving rules for the regulation and speeding. Ill. 2300 w. Engr, U S A—Nov. 2, 1903. No. 58974 C.

Grinding.

Emery Wheel Practice in Foundries. Charles G. Smith. Read before the Pittsburg Found. Assn. Discusses foundry grinding, especially the uses for emery wheels. 2300 w. Foundry—Nov., 1903. No. 58698.

Universal and Tool Grinding Machine.

Illustrated detailed description of a new machine. 800 w. Am Mach—Nov. 5, 1903. No. 58823.

Index Plates.

Making Accurate Index Plates. Jos. M. Stabel. Illustrates and describes methods used by the writer. 1400 w. Am Mach—Nov. 19, 1903. No. 59015.

Lathes.

Automatic Turret Lathe Development at the Works of the Potter & Johnston Machine Company. Illustrated description of the lines of development. 1500 w. Am Mach—Nov. 5, 1903. No. 58822.

Brass-Finishers Lathes. Illustrated description of lathes especially designed for repetition work. 1800 w. Engng—Nov. 13, 1903. No. 59075 A.

Lathe Work.

Rapid Reduction in the Lathe as Compared with Forgings. Frank B. Kleinhaus. Illustrated description of methods of arrangement of tools for rapid reduction work. 800 w. Eng News—Nov. 5, 1903. No. 58862.

Milling.

Large Plano-Milling and Profiling Machine. An illustrated description of a machine designed for heavy work. 800 w. Engr, Lond—Oct. 30, 1903. No. 58805 A.

Molding.

Drying Molds. Henry Hess. Remarks on methods, with description of a combination of small stove, small blower, and small electric motor to drive the blower. 1000 w. Foundry—Nov., 1903. No. 58699

The Bottom of a Green Sand Mold. Thomas D. West. Read before New England Foun. Assn. A discussion of the principles involved in making green sand castings, illustrating methods commonly practiced. 3000 w. Ir Trd Rev—Nov. 12, 1903. No. 58938.

The Top of a Green Sand Mold. Thomas D. West. Read at meeting of New England Found. Assn. Considers points of importance, and methods of securing desired results. 4000 w. Ir Trd Rev—Nov. 19, 1903. No. 59223.

New Plant.

The Ambridge Plant of the American Bridge Company. An illustrated description of the arrangement, operation, power, transportation and buildings. 5500 w Eng Rec—Nov. 21, 1903. Serial. 1st part. No. 59202.

Pipe Foundry.

Pipe Foundry of the Massillon Iron & Steel Company, Massillon, O. Illustrated detailed description of the plant and its equipment. 1200 w. Foundry—Nov., 1903. No. 58700.

Rolling Mill.

Reverse Curves Rolling Mill. Illustrated description of a machine designed for the rolling of reverse curves from the flat strip or hoop. 1000 w. Engr, Lond—Oct. 30, 1903. No. 58808 A.

Rolls.

The Calibration of Rolls (Das Kalibrieren der Walzen). Alexander Sattmann. A discussion of the method of proportioning the passes in the rolls of mills for rolling structural shapes of iron or steel, so as to effect the reduction and forming of the desired profiles. 3000 w. Oesterr Zeitschr f Berg u Hüttenwesen—Oct. 17, 1903. No. 59130 D.

The Calibration of Rolls for Rolling Mills (Die Kalibrierung der Walzen im Walzwerksbetriebe). Emil Kirchberg. Describing the method of laying out the passes in rolls for rolling I beams and structural shapes. 3500 w. Stahl u Eisen—Oct. 15, 1903. No. 59156 D.

Screw-Threads.

Cutting Fractional Screw Threads. Fred H. Colvin. An explanation of ways of solving various problems. 1800 w. Mach, N Y—Nov., 1903. No. 58758 C.

Shears.

Electric, Steam and Hydraulic Shears at German Steel Works. Frank C. Perkins. Illustrates and describes various types. 1600 w. Mod Mach—Nov., 1903. No. 58786.

Shops.

New Shop of the Cincinnati Shaper Co. Illustrated description of a shop manufacturing crank, geared and traverse shapers. 2000 w. Mach, N Y—Nov., 1903. No. 58756 C.

The Works of Messrs. Meldrum Brothers, Ltd. An illustrated detailed description of new works and their equipment, near Manchester, Eng. 5500 w. Trac & Trans—Nov., 1903. No. 58899 E.

Works of the Marine Engine and Machine Co. Illustrates and describes these large modern shops at Harrison, N. J., and the methods and processes used in a wide range of work. 3500 w. Eng Rec—Oct. 31, 1903. No. 58762.

See Railway Engineering, Permanent Way and Buildings.

See Street and Electric Railways.

Steel Castings.

Steel Castings and the Tropenas Process. Arthur Simonson. Read at meeting of the New England Found. Assn. Considers steel and its characteristics, the manufacture of steel castings, and problems of the foundry, the sphere of the Tropenas process and the features of operation. 4000 w. Ir Trd Rev—Oct. 29, 1903. No. 58746.

MATERIALS OF CONSTRUCTION.

Alloys.

Alloys of Aluminum. From a paper by Joseph W. Richards before the Am. Soc. of Test. Materials, on the qualities of the different alloys and their preparation. 600 w. Am Mach—Nov. 12, 1903 No. 58931.

Aluminothermics.

Alumino-thermics and Rail Welding. Dr. Hans Goldschmidt. Abstract of a lecture before Columbia Univ. Chem. Soc. Describes the process of thermic welding, giving report of tests made on the strength of thermit joints. Ill. 1800 w. St Ry Jour—Nov. 14, 1903. No. 58953 C.

Aluminothermics. Hans Goldschmidt. Chiefly considers the practical applications Supplementary to an article by Dr. G. P. Scholl, in Jan. issue. Ill. 4500 w. Electro-Chem Ind—Nov., 1903. No. 58928 C.

The Aluminothermic Processes (Les Procédés Aluminothermiques). E. Dieudonné. Describing the practical applications of the Goldschmidt process to the welding of rails and similar operations. 2000 w. Revue Technique—Oct. 25. 1903. No. 59117 D.

Deformations.

An Experimental Study of Permanent Deformations (Etude Experimentale des Deformations Permanentes). H. Bouasse. A fundamental treatment of the deformation of materials produced by stresses of various kinds. 7500 w. Bull Soc d' Encour—Oct. 31, 1903. No. 59126 G.

Ferro-Alloys.

On the Manufacture of Ferro-Alloys in General and of Ferro-Titanium in Particular in the Electric Furnace. Auguste J. Rossi. Treats of the electrical smelting and the reduction. 5000 w. Electro-Chem Ind—Nov. 1903. No. 58927 C.

Rust.

The Pitting Rust of Iron. Dr. W. H. Birchmore. An account of the writer's observations and experiments in making a study of this trouble. 2800 w. Am Gas Lgt Jour—Nov. 16, 1903. No. 58941.

Testing.

The Influence of Form and Production upon the Resistance of Cast Iron Test Pieces (Einfluss der Form und Herstellungsweise von Gusseisernen Probestäben auf deren Festigkeit). P. Reusch. With numerous examples showing how the apparent resistance may vary according to the shape and manner of casting. 2500 w. Stahl u Eisen—Nov. 1, 1903. No. 59157 D.

Tool Steels.

Experiments with High-Speed Tool Steels. Report on experiments with rapid-ing steel tools made at the Manchester g.) Municipal School of Technology, under the auspices of a joint committee, to test the capabilities. Also editorial. 6000 w. Mech Engr—Oct. 31, 1903. Serial. 1st part. No. 58791 A.

High-Speed Tool Steels. Review of Dr Nicolson's report of tests made on lathe tools. 3500 w. Engr, Lond—Oct. 30, 1903 No. 58803 A.

Rapid-Cutting Tool Steels. Dr. J. T. Nicolson. Report on experiments with rapid-cutting tool steels, made under the auspices of a Joint Committee. Ill. 8000 w. Engng—Oct. 30, 1903. Serial. 1st part. No. 58798 A.

Rapid-Cutting Tool Steels. Report of the discussion on the paper read by Dr. J. T. Nicolson. 6500 w. Engng—Nov. 13 1903. No. 59074 A.

Wire.

Hard Drawn Copper Wire. Francis W. Jones. Abstract from *Telegraph Age*. Some points on the properties of this wire, the sag and elongation. 1000 w. Elec Rev. N Y—Nov. 21, 1903. No. 59209.

MEASUREMENT.

Centrifugal Force.

Centrifugal Force and its Applications in General and Technical Mechanics (Die Zentrifugalkräfte und ihre Anwendung in der Kosmischen und Technischen Mechanik). Dr. Holzmüller. A summary of the laws governing the action of centrifugal force, considered both in relation to space in general, and in connection with the attraction of the earth. 3500 w. Zeitschr d Ver Deutscher Ing—Nov. 7. 1903. No. 59107 D.

Dynamometers.

European Designs of Dynamometers. E. P. Buffet. Illustrated descriptions derived from articles in the *Revue Industrielle*, and *Kraft*. 1500 w. Am Mach—Nov. 26, 1903. No. 59253.

Metric System.

See Marine and Naval Engineering.

Screw-Measuring.

Screw-Measuring Machine at the National Physical Laboratory. Illustrates and describes a machine for micrometrically testing the accuracy of commercially-produced screw-threads and taps. 1200 w. Engng—Nov. 13, 1903. No. 59076 A.

POWER AND TRANSMISSION.

Air Compressor.

A New Type of Air Compressor. W. H. Booth. Illustrates and describes a compact, duplex, two-stage compressor, direct-driven by an electric motor, adapted to use in mines or shops. Made by an English company. 2200 w. Mines & Min—Nov., 1903. No. 58740 C.

Four-Stage Air Compressor for 850-lbs. Pressure. Illustrated description of an interesting machine recently installed at the Aragon mine at Norway, Mich., for the purpose of supplying compressed air for locomotives for the haulage system. 1700 w. Eng News—Nov. 26, 1903. No 59255.

Ball Bearings.

Diagram for Fnding the Diameter of Ball Bearings. P. S. Bushnell. With explanatory notes. 500 w. Am Mach—Nov. 12, 1903. No. 58932.

Compressed Air.

The Use of Compressed Air for Operating the Contractor's Plant at the Wachusett Dam. An account of the use of compressed air on a large scale in contract work noting some of its advantages. Ill. 1200 w. Eng News—Nov. 26, 1903. No. 59254.

Transmission of Compressed Air for Power. L. C. Bayles. Explains the method of determining the most economical size of pipe to use for the transmission. 700 w. Compressed Air—Nov., 1903. No. 59032.

Conveying Machinery.

Recent Developments in Conveying Machinery. A. Little. Abstract of a paper read before the Birmingham Assn. of Mech. Engrs. Describes briefly installations showing the progress made. 2700 w. Prac Engr—Nov. 13, 1903. No. 59200 A.

Pneumatic Tubes.

Pneumatic Tube System of the New York Stock Exchange. Edmund A. Fordyce. Brief illustrated description of the installation, with remarks on the importance of the service. 1000 w. Compressed Air—Nov., 1903. No. 59031.

Power Generation.

The Value of Combustibles for the Generation of Power (Die Auswertung der Brennstoffe als Energieträger). C. Linde. An important paper before the *Verein Deutscher Ingenieure* discussing the transformation of heat energy into mechanical work 5000 w. Zeitschr d Ver Deutscher Ing—Oct. 17, 1903. No. 59100 D.

Shafts.

A chart for Calculating the Strength of shafts and Pins. Gilbert S. Walker. Gives a draft intended to simplify the calculations, with explanatory notes. 2200 w. Am Mach—Nov. 26, 1903. No.59252.

SPECIAL MOTORS.

Gas Engines.

Different Gases in Gas Engines. Prof. Alfred H. White. Lecture delivered at the Detroit meeting of the Am. Gas Lgt. Assn. Considers the influence of the kind of gas used, explaining the phenomena which take place in the engine cylinder. 5500 w. Am Gas Lgt Jour—Nov. 16, 1903. No. 58940.

700-Horse-Power Double-Acting Gas-Engine; Körting System. An illustrated detailed description of the engine and its working. 1600 w. Engng—Oct. 30, 1903. No. 58799 A.

1,600 Horse-Power Gas Engine and Three-Phase Alternator at Laar Power Plant, and Other High-Power Blast Furnace Gas Engines. Frank C. Perkins. Illustrations with brief descriptions. 900 w. Elec Rev, N Y—Nov. 7, 1903. No. 58859.

Gasoline Engines.

See Marine and Naval Engineering.

Gas Power.

Experiments on a Suction Gas Plant (Untersuchungen an einer Sauggasanlage). Kurl Bräuer. Data and results of tests. The suction stroke of the gas engine produces the down draft in the producer. A fuel consumption of 0.32 kilogram of coal per 1 H. P. was attained. 4000 w. Zeitschr d Ver Deutscher Ing—Oct. 17, 1903. No. 59101 D.

The Economical Use of Engines Fed with Lean Gas (Emploi Economique des Moteurs à Gas Pauvre). F. Gramyr. A description of the gas producer engines, and machinery installed at the potteries at Embrach. 4000 w. Revue Technique—Nov. 10, 1903. No. 59118 D.

Internal Combustion.

See Mechanical Engineering, Automobiles.

STEAM ENGINEERING.

Boilers.

Circulation in Water-Tube Boilers. Suggests a cause which it is believed will not only account for circulation, but for erratic performances which frequently cause disaster. 2800 w. Engr, Lond—Nov. 6, 1903. No. 59012 A.

Water-Tube Boilers. William Fyvie. States the factors in favor of water-tubes for land purposes, discussing each, and also considering the weaknesses. 2400 w. Aust Min Stand—Oct. 1, 1903. Serial. 1st part. No. 58906 B.

See Marine and Naval Engineering.

See Railway Engineering, Motive Power.

Boiler Setting.

Boiler Settings. Charles L. Hubbard. An illustrated article considering the important requirements. 1800 w. Am Elect'n—Nov., 1903. No. 58885.

Boiler Tubes.

Non-Corrosive Nickel Steel Boiler Tubes. Albert Ladd Colby. Information concerning nickel-steel tubes as made in Europe and America, cost, properties, applications, etc. Ill. 5000 w. Trans Am Soc Nav Archts & Marine Engrs, No. 7—Nov., 1903. No. 59043 D.

Condenser.

The Central Condenser Plant at the Maria Mine at Pribram (Die Zentral Kondensationsanlage System Balcke am Mariaschachte in Pribram). Julius Divis. Describing a condenser plant receiving the exhaust of all the engines of the mine; Balcke cooling towers are used, and 43,000 kilograms of steam condensed in 24 hours. 3000 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—Oct. 31,1903. No. 59132 D.

Connecting Rods.

The Acceleration Stresses on Connecting Rods (Der Beschleunigungsdruck der Schubstange). Dr. R. Mollier. An analytical and graphical examination of the stresses produced in connecting rods by the acceleration changes at various parts of the stroke. 1800 w. Zeitschr d Ver Deutscher Ing—Nov. 7, 1903. No. 59108 D.

Locomotive Connecting and Side Rods. George Willans. An illustrated investigation of the designs of modern rods, comparing them with earlier practice. 2200 w. Prac Engr—Nov. 13, 1903. Serial. 1st part. No. 59099 A.

Crank Pins.

Keying Up Crank Pins. William Kavanagh. Describes various methods, and considers the causes of heating. 1200 w. Power—Nov., 1903. No. 58833.

Engines.

Adjusting Clearance and Setting the Valves of Corliss Steam Engines. John L. Plock. Describes method, giving illustration. 1500 w. Power—Nov., 1903. No. 58830 C.

A New Type of Steam Engine (Nouveau Type de Machine à Vapeur). A discussion of an ideal type of steam engine suggested by M. Friedenthal in which a combustible vapor should be used first to develop its expansive force and then burned. 2000 w. Revue Technique—Nov. 10, 1903. No. 59119 D.

Heat Economy of the Steam Engine. Translated from Prof. Lynen's "Die Wärmeausnutzung bei der Dampfmaschine." Ill. 5600 w. Stevens Inst—Oct., 1903. No. 59295 D.

The Franco Tosi Engines. A. H. Allen. Illustrated detailed description of types made in Italy. 1300 w. Engr, U S A—Nov. 2, 1903. No. 58972 C.

Evaporators.

See Marine and Naval Engineering.

Flywheels.

Flywheels and Flywheel Accidents. R. T. Strohm. Considers the stresses set up when a flywheel revolves at a constant velocity, the causes of flywheel destruction and the prevention of disasters. 3300 w. Am Elect'n—Nov., 1903. No. 58882.

The Weight of a Flywheel Rim. R. T. Strohm. Explains the method of computing. 2000 w. Power—Nov., 1903. No. 58835 C.

Fuel Losses.

Fuel Losses in Steam Plants, and How to Determine Them. George H. Barrus. Outlines methods of testing and sources of waste that may be determined by observation. 3000 w. Cassier's Mag—Nov., 1903. No. 58895 B.

Furnace Gas.

Errors in Analyses of Furnace Gases Shown by Computation. William Kent. Mathematical demonstration. 1000 w. Stevens Ind—Oct., 1903. No. 59294 D.

Heating Plants.

Central Heating Plants at Indianapolis, Ind. W. K. Eldridge. Abstract of a paper read at meeting of the Am. Soc. of Munic. Imp. A report of plants operating in conjunction with electric lighting stations. 1200 w. Eng News—Nov. 5, 1903. No. 58870.

Inspection.

The Growth of the Hartford Company. A graphical analysis, with notes, showing the work done by the Hartford Steam Boiler Inspection and Insurance Company. 1200 w. Locomotive—July, 1903. No. 58809.

Oil Fuel.

Oil-Fired Furnaces. A. M. Bell. Considers some of the applications for which oil fuel is especially adapted, and gives illustrated descriptions of types of furnaces used. 2500 w. Cassier's Mag—Nov, 1903. No. 58896 B.

Reversing Gear.

The Woolf Reversing Motion. Frederick H. Stacey. An illustrated article explaining the functions and laws on which the working of a radial valve gear for traction engines depends. 1400 w. Power—Nov., 1903. No. 58834 C.

Steam Flow.

The Flow of Gases and Steam through Tubes of Variable Section (Die Stationäre Strömung von Gasen und Dämpfen durch Rohre mit Veränderlichem Querschuitt). H. Lorenz. With especial reference to the action in nozzles of steam turbines and similar machines. 2500 w. Zeitschr d Ver Deutscher Ing—Oct. 31, 1903. No. 59105 D.

Steam Pipes.

Notes on the Arrangement and Construction of Steam Pipes and Their Connections. Robert C. Monteagle. Points out some of the causes of failure, describing points in design, and considering material. Ill. 4000 w. Trans Am Soc Nav Archts & Marine Engrs, No. 3—Nov., 1903. No. 59039 D.

Stoking.

Kilroy's Stoking Indicator. An illustrated description of an electrical apparatus to aid in better and more regular stoking. 700 w. Elec Rev, Lond—Oct. 23, 1903. No. 58726 A.

Superheating.

The Generation of Superheated Steam (Die Erzeugung des Ueberhitzten Wasserdampfes). Dr. Otto Berner. A discussion of the construction of superheaters, with tabulated data of results of experimental researches. Two articles. 10,000 w. Zeitschr d Ver Deutscher Ing—Oct. 24, 31, 1903. No. 59102 each D.

Steam Alternator Working with Highly Superheated Steam. E. Kilburn Scott. A summary of results obtained by Prof. Ewing in tests upon a 300 I. H. P. single crank compound jet condensing engine. Ill. 1700 w. Tram & Ry Wld—Nov. 12, 1903. No. 59249 C.

Turbines.

Some Notes on Steam Turbo-Electric Generating Plants. George Wilkinson. Read before the Leeds Local Soc. of the Inst. of Elec. Engrs. Gives the leading characteristics of various types of turbo-generators, with suggestions from the writer's experience. 4800 w. Elect'n, Lond—Oct. 23, 1903. No. 58732 A.

The Steam Turbine Installation of the B. F. Goodrich Company. Illustrated description of a plant at Akron, Ohio, in which the steam turbine and electric motor are the important factors in the economical generation and use of power. 4800 w. Eng Rec—Nov. 7, 1903. No. 58837.

U. S. Navy.

Steam Engineering in the Navy. Extracts from the report of Admiral Rae, in which the needs of the principal navy yards are pointed out. 3800 w. Ir Age—Nov. 5, 1903. No. 58772.

MISCELLANY.

Aeronautics.

Recent Aeronautical Progress, and Deductions to be Drawn Therefrom, Regarding the Future of Aerial Navigation. Major B. F. S. Baden-Powell. Presidential address before the Aeronautical Society of Great Britain. 5000 w. Sci Am Sup—Nov. 21, 1903. No. 59030.

The Barton Airship. An illustrated description of the construction. 1800 w. Auto Jour—Nov. 14, 1903. No. 59095 A.

The Beedle Airship. Illustrations with brief description. 800 w. Auto Jour—Nov. 7, 1903. No. 58990 A.

The Mechanical Principles of Aeronautics (Die Mechanischen Grundgezetze der Flugtechnik). A. Budan. A general review of the mechanics of dirigible balloons and aeroplanes. Two articles, 6000 w. Zeitschr d Oesterr d Ing u Arch Ver—Oct. 16, 23, 1903. No. 59120 each D.

Refrigeration.

The Manufacture of Artificial Ice. Oswald Gueth. A lecture delivered before the Jas. Watt Assn. Illustrates and describes the methods used in the manufacture of artificial ice for commercial purposes. 2300 w. Engr, U S A—Nov. 2, 1903. Serial. 1st part. No. 58973 C.

Wood Chopping.

A New Hard Wood Chopping Plant. Illustrated description of a new machine for chopping the hardest woods, describing its action. 1200 w. Engr, Lond—Nov. 6, 1903. No. 59013 A.

MINING AND METALLURGY

COAL AND COKE.

Coal Feeding.

Coal Feeding Difficulties in Hoppers and Spouts. William L. Morris. Discusses defects in design, and other factors that enter into the maintenance of a uniform "dead fire line." Ill. 2000 w. St Ry Rev—Nov. 20, 1903. No. 59242 C.

Coal Storage.

Observations Upon the Sub-Aqueous Storage of Steam Coal. J. Macaulay. Reasons and suggestions in explanation of the seeming increase in calorific value of coal stored under water. 3500 w. Engr, Lond—Oct. 30, 1903. No. 58802 A.

Coking.

Reactions and Temperatures in By-Product Coke Ovens. Describes some of the peculiarities in the progress of coking through the charge. 1200 w. Ir & Coal Trds Rev—Oct. 30, 1903. No. 58907 A.

Great Britain.

The Coal Mining Industry of the United Kingdom. R. A. S. Redmayne. Professor Redmayne's third and concluding paper reviews the present economic conditions of coal mining in Great Britain, together with the questions of future supply and foreign competition. 3000 w. Engineering Magazine—Dec., 1903. No. 59167 B.

Natal.

Coal-Mining in Natal. Information from the report of C. J. Gray, Commissioner of Mines for Natal. 1800 w. Col Guard—Nov. 6, 1903. No. 59002 A.

New South Wales.

Coal-Mining in New South Wales. Information from the annual report of the output, value, etc. 2500 w. Col Guard—Oct. 23, 1903. No. 58727 A.

Production.

Coal Production and Consumption of the Principal Countries of the World. A statement of the production, value, etc., of coal in the five principal coal-producing countries of the world. 3000 w. Col Guard—Oct. 30, 1903. No. 58795 A.

Coal Production and Consumption. Editorial review of the returns from all the large industrial countries, recently published by the British Board of Trade. 1800 w. Engng—Nov. 13, 1903. No. 59077 A.

COPPER.

Commercial Copper.

See Electrical Engineering, Electro Physics.

Price.

The Price of Copper. Discusses the effect of the decision to close down the Montana mines. 1200 w. Engr, Lond—Oct. 30, 1903. No. 58806 A.

Refining.

Electrolytic Copper Refining. Wilder D. Bancroft. Abstract of a paper read at the Niagara Falls meeting of the Am. Elec. Chem. Soc. A report of tests made to determine the relation between voltage, current density and temperature for pure copper plates set definite distances apart in four solutions of compositions used in practice. Also other data. 1500 w. Eng & Min Jour—Nov. 14, 1903. No. 59230.

Siberia.

Mining in the Kirghiz Steppes. E. Nelson Fell. An illustrated article describing the country, its geology, the history of mining in the region, methods, etc., with a brief outline of the Yuspenski copper mine, which is the only one seriously developed. 5000 w. Eng & Min Jour—Nov. 14 & 21, 1903. Serial. 2 parts. No. 59225.

Smelting.

Copper Smelting at Anaconda. A. P. Mallon. A description of how the ores are treated. 1200 w. Pacific C Min—Nov. 14, 1903. No. 59069.

GOLD AND SILVER.

Assaying.

Assaying of Gold and Silver at the United States Mint. John W. Pack. An explanation of the methods employed. 3000 w. Min & Sci Pr—Nov. 14, 1903. No. 59239.

Black Hills.

Ore Deposits of the Northern Black Hills. J. D. Irving. Extracts from a paper read at the Am. Min. Cong. Describes the geology, deposits of gold-bearing rocks and gravels, the development, etc. 3000 w. Min Rept—Nov. 19, 1903. No. 59232.

British Columbia.

Alluvial Deposits of Horsefly, B. C. W. M. Brewer. Illustrates and describes the placer and hydraulic mines of this portion of the Cariboo district. 1200 w. Min & Sci Pr—Oct. 31, 1903. Serial. 1st part. No. 58818.

Hydraulic Mining on the Quesnelle. William M. Brewer. Describes this portion of the Cariboo mining district, giving details of operation and results obtained by hydraulic mining of these auriferous gravels. 2300 w. Eng & Min Jour—Oct. 31, 1903. No. 58776.

Through the Lardeau. An account of recent progress and present day conditions in the Trout Lake division, and about Fish River, and its creeks. 7400 w. Ill. B C Min Rec—Nov., 1903. No. 58925 B.

California.

The Cretaceous Auriferous Conglomerate of the Cottonwood Mining District, Siskiyou County, California. H. W. Turner. Describes the formations of this district. 3500 w. Eng & Min Jour—Oct. 31, 1903. No. 58774.

Classification.

Notes on Classification. T. Lane Carter. and D. V. Burnett. Discusses classification in its relation to the cyanide process. Ill. 4500 w. Jour Chem, Met & Min Soc of S Africa—Sept., 1903. No. 59064 E.

Colloidal Gold.

On Colloidal Gold: Adsorption Phenomena and Allotropy. J. C. Blake. An investigation of garnet-colored solution of Colloidal gold with regard to the adsorption phenomena of the gold when precipitated by electrolytes, with observations on the apparent allotropy. 1800 w. Am Jour of Sci—Nov., 1903. No. 58695 D.

Concentration.

A System of Continuous Concentration of Ores by Oil. J. W. Van Meter. Illustrated description of the Van Meter-Boss system. 1400 w. Min & Sci Pr—Nov. 7, 1903. No. 58947.

Cyaniding.

A New and Rapid Method of Detecting and Estimating Gold in Working Cyanide Solutions. James Moir. Describes the process. 2500 w. Jour Chem, Met & Min Soc of S Africa—Sept., 1903. No. 59065 E.

Cyaniding Sluices at Cobar (N. S. W.). F. Danvers Power. Describes the filter-press method adopted. Ill. 2000 w. Aust Min Stand—Oct. 15, 1903. No. 58993 B.

The Regeneration of Working Cyanide Solutions When Zinc Precipitation is used. Discussion of paper by A. F. Crosse. 7500 w. Jour Chem, Met & Min Soc of S Africa—Sept., 1903. No. 59062 E.

Dredge.

Prospecting Gold Dredge with Steel Hull. Describes a prospecting dredge of all steel construction, designed to clean up bedrock at 22 ft. depth, and to handle free material at the rate of 60 tons per hour. 1700 w. Eng & Min Jour—Nov. 7, 1903. No. 58851.

Estimating.

The Colorimetric Estimation of Gold in Cyanide Solutions. Henry R. Cassel. Describes an easy and quick method of estimating by eliminating the cyanogen present and then using the "Purple of Cassius" test. 1100 w. Eng & Min Jour—Oct. 31, 1903. No. 58778.

Ferrocyanides.

An Examination of Various Methods for the Estimation of Ferrocyanides. J. E. Clennell. A summary of the most promising of the methods examined in an investigation made. 5000 w. Eng & Min Jour —Nov. 7, 1903. No. 58848.

Kalgoorlie.

I. Grinding Machines Used at Kalgoorlie. II. Dry-Crushing and Roasting at Kalgoorlie. Two articles abstracted from a paper by W. Evav Simpson, describing the treatment of telluride ores. 4000 w. Eng & Min Jour—Nov. 14 & 21, 1903. Two parts. No. 59226.

Permanence in Depth in Kalgoorlie. H. C. Hoover. Abstract of paper on "The Future Gold Production of Western Australia," in the *Pro.* of the Inst. of Min. & Met., London. Briefly describes these deposits, their value, origin, etc., 900 w. Eng & Min Jour—Oct. 31, 1903. No. 58775.

Mexico.

Ancient and Modern Mexican Metallurgy. A. W. Warwick. The present article considers the patio process, and the results. 700 w. Min Rept—Nov. 12, 1903. Serial. 1st part. No. 58965.

Michipicoten.

Notes on the Michipicoten Gold-Belt. C. H. Clarke. An account of this Lake Superior region and its development. 2000 w. Eng & Min Jour—Nov. 14, 1903. No. 59228.

Montana.

The Elkhorn Mining District of Montana. Abstract and notes by Arthur Lakes of article by W. H. Weed in the Annual Report of the U. S. Geol. Survey. Silver, a little gold, copper, lead, etc. Ill. 2400 w. Mines & Min—Nov., 1903. No. 58741 C.

Moore Process.

The New Moore Process as Installed at the Consolidated Mercur Gold Mines. George Moore. An illustrated description of this process for the treatment of slimes. 1300 w. Min Rept—Nov. 12, 1903. No. 58964.

Nevada.

The Ore Deposits of Tonopah, Nevada. J. E. Spurr. An illustrated description of the geology, mineralization, occurrence, etc. The mines are worked for the silver, though other minerals of value are found. 1800 w. Eng & Min Jour—Nov. 21, 1903. No. 59231.

Placers.

Undercurrents for Saving Flour Gold and Platinum Sands. Dennis H. Stovall. Describes the system in use at the Royal Group hydraulic mines of Galice District, Oregon. Ill. 800 w. Min & Sci Pr—Oct. 24, 1903. No. 58755.

Production.

The Greatest Gold-Producing Mines. J. H. Curle. Brief outlines of the best producers, with table giving an approximate estimate of 30 of the greatest gold producing mines of the present. Three are in the United States. 1400 w. Eng & Min Jour—Nov. 7, 1903. No. 58847.

Quartz Milling.

Notes on the Common Practice of Quartz Milling on the Rand. Discussion of paper by Fraser Alexander. 4500 w. Jour Chem, Met & Min Soc of S Africa—Sept., 1903. No. 59066 E.

Sulphide Ores.

A Dry Process for the Treatment of Complex Sulphide Ores. H. Livingstone Sulman and Hugh Kirkpatrick Picard. Read before the Inst. of Min. & Met. Describes the application of the writer's process to these ores, giving just a brief sketch of other processes. 7500 w. Can Min Rev —Oct. 31, 1903. No. 58765 B.

Thunder Mountain.

Thunder Mountain Region, Idaho County, Idaho. Notes on the development work done and under way in the Thunder Mountain and Big Creek mining districts. 2200 w. Min Rept—Nov. 5, 1903. No. 58924.

Thunder Mountain Region, Idaho County, Idaho. Continued account of important development work under way in this region. 2000 w. Min Rept—Nov. 12, 1903. No. 58967.

Witwatersrand.

The Witwatersrand Gold Deposits and Their Associated Rocks. Frederick H. Hatch. Discussion of papers by J. S. Curtis and G. A. Denny. Read before the So. African Assn. of Engrs. 2000 w. Eng & Min Jour—Nov. 7, 1903. No. 58849.

The Witwatersrand Ore Deposits. G. A. Denny. Abstract of discussion of a paper by J. S. Curtis, read before the So. African Assn. of Engrs. 3000 w. Eng & Min Jour—Oct. 31, 1903. No. 58777.

IRON AND STEEL.

Blast Furnaces.

The Blast Furnaces of Schneider & Co., at Cette (Les Haut Fourneaux Schneider et Cie. de Cette). An illustrated description of the large iron works at Cette, operated in connection with the other establishments of Schneider & Co. 5000 w. Revue Technique—Oct. 25, 1903. No. 59115 D.

New Blast Furnace Plant of the Toledo Furnace Co., at Toledo, Ohio. Illustrates and describes a well equipped plant for the production of foundry iron. 2800 w. Ir Trd Rev—Nov. 5, 1903. No. 58817.

Blow Holes.

Preventing Pipes and Blow Holes in Ingots and Castings. Dr. F. C. Weber. Describes the writer's work in this field, and comments on an article on this subject in *Stahl und Eisen*. 1700 w. Ir Age—Nov. 12, 1903. No. 58857.

Elba.

Blast-Furnace Plant on the Island of Elba (Hochofenanlage auf der Insel Elba). J. Nebelung. An illustrated account of the working of the extensive iron ore deposits on the island, with details of the furnaces and machinery of the new works at Portoferraio. Two articles. 6000 w. Zeitschr d Ver Deutscher Ing-Oct. 24, Nov. 7 1903. No. 59103. Each D.

Electric Installation of the Elba Iron Works (Installation Electrique des hauts Fourneaux de la Société Elba). Describing the power station, electric pumps, and general arrangement. Gas engines using waste furnace gases are used. 2000 w. Génie Civil—Oct 24, 1903. No. 59110 D.

Foundry Iron.

See Mechanical Engineering, Machine Works and Foundries.

Grading.

Features and Characteristics of Iron and Steel. R. G. Griswold. Illustrated article discussing what may be learned from the appearance of fractures, and considering the grades of cast iron, also wrought iron and steel. 2500 w. Power—Nov., 1903. No. 58831 C.

Improvements.

British Improvements in Iron and Steel Making. An address delivered before the Staffordshire Iron & Steel Inst., by Mr. Walter Macfarlane. 4700 w. Engr, Lond—Nov. 13, 1903. No. 59083 A.

Lackawanna Plant.

W. W. Scranton on the Lackawanna Plant. An interesting letter to the Scranton *Times*, largely in praise of the new plant at Buffalo. 1200 w. Ir Age—Nov. 10, 1903. No. 59018.

Open Hearth.

The Cost of Open-Hearth Steel as Affected by Using Blast Furnace Gas in Gas Engines, and Remarks on the Latest Improvements. Peter Eyermann. Gives some important points in relation to gas engines, and calculations, indicating how great economy may be affected. 6400 w. Jour Assn of Engng Soc—Sept., 1903. No. 59272 C.

Ore.

Treatment of Finely Divided Iron Ore. Prof. Léonce Fabre, in *Revue de Chimie Industrielle*. Describes the principal processes now followed. 1500 w. Sci Am Sup—Nov. 7, 1903. No. 58889.

Philippine Islands.

The Iron Mines of Angat, Philippine Islands. H. D. McCaskey. An illustrated article referring to iron deposits of value in the province of Bulacan, Central Luzon. 1200 w. Eng & Min Jour—Nov. 14, 1903. Serial. 1st part. No. 59229.

Rolling Mill.

See Mechanical Engineering, Machine Works and Foundries.

Rolls.

See Mechanical Engineering, Machine Works and Foundries.

Steel.

Manganese Steel (Aciers au Manganese). L. Guillet. A study of the different series showing the physical, chemical, and industrial properties. 6000 w. Bull Soc d' Encour—Oct. 31, 1903. No. 59124 G.

Steel Works.

Blast Furnaces and Steel Plant of the Clairton Steel Co., at Clairton, Pa. Illustrated detailed description of large works recently erected. 3000 w. Ir Trd Rev—Nov. 19, 1903. No. 59224.

Transformations.

The Allotropic Transformations of Iron and Its Alloys (Transformations Allotropiques du Fer et de ses Alliages). O.

Boudouard. Data and results of experiments with numerous diagrams, tables, and a bibliography. 10,000 w. Bull Soc d' Encour—Oct. 31, 1903. No. 59125 G.

MINING.

Ankylostomiasis.

Ankylostomiasis. The first installment of a series of illustrated articles on the worm disease infecting mines of continental Europe. 3200 w. Col Guard—Nov. 6, 1903. Serial. 1st part. No. 59001 A.

Ankylostomiasis in Westphalian Collieries. J. S. Haldane. From a report to the Sec. of State for the Home Dept. Considers the source of the infection, the conditions affecting the spread, measures taken to combat the disease, the results, prevention, &c. 6400 w. Ir & Coal Trds Rev—Nov. 13, 1903. No. 59071 A.

Dikes.

Dikes and Intrusive Sheets. Explains these terms and the means of distinguishing, giving information of interest because of their frequent connection with ore deposits. 1200 w. Min Rept—Oct. 29, 1903. No. 58743.

Doors.

Automatic Shaft Doors (Selbsttä tige Schachtverschlüsse). H. Siede. Illustrating and describing the Münger form of sliding doors for mine shafts, operated automatically by the cage. 1000 w. Glückauf—Oct. 31, 1903. No. 59135 D.

Explosives.

Explosives on the Witwatersrand. T. Lane Carter. Facts illustrating the cost of dynamite before the war and at the present time, with information regarding other explosives. 1200 w. Eng & Min Jour—Nov. 7, 1903. No. 58850.

Hoisting.

Electric *versus* Steam Mine Hoisting Machinery. Frank C. Perkins. Describes installations in Europe, showing that while steam is generally used, electric hoists do the work equally well, and will probably be installed in new works. Ill. 800 w. Min Rept—Nov. 5, 1903. No. 58922.

Hoisting Plant and Steel Shaft House for the Oliver Iron Mining Co., at Ely, Minn. An illustrated detailed description of an interesting plant and its equipment. 3500 w. Eng News—Nov. 19, 1903. No. 59023.

Some Notes on Certain Underground Hoisting Problems on the Witwatersrand. A. W. K. Pierce. Describes the conditions to be met, considering the best method for this important hoisting work to be a combination of polyphase transmission, conversion to direct currents and the utilization of the conversion machinery for controlling the hoisting operations. 2800 w. Trans Am Inst of Elec Engrs—Oct., 1903. No. 59288 D.

Ignition.

Progress in Ignition of Mine Explosives (Fortschritte im Minenzündwesen). Johann v. Lauer. A review of the development of friction primers and electric igniters for mining explosives since 1886. Two articles. 3000 w. Oesterr Zeitschr f Berg ú Hüttenwesen—Oct. 24, 31, 1903. No. 59131 each D.

Leasing.

The Leasing System. Prof. Arthur Lakes. Describes a method of working mines which is operated on both large and small scales and is applicable to peculiar conditions. 2000 w. Mines & Min—Nov., 1903. No. 58742 C.

Mine Equipment.

Equipment of the Sultan Mine, Arizona. Charles E. Bunker. Begins an illustrated detailed description. 1400 w. Min & Sci Pr—Nov. 14, 1903. Serial. 1st part. No. 59240.

Mine Gases.

Some Mine Gases: Their Toxicology and Possible Connection with Miners' Phthisis. Discussion of a paper by A. Heymann. 13000 w. Jour Chem, Met & Min Soc of S Africa—Sept., 1903. No. 59063 E.

Mine Opening.

A Number Scheme for Mines. Matt W. Alderson. An explanation of system adapted to the needs of mine development. 1200 w. Min & Sci Pr—Oct. 24, 1903. No. 58754.

Rock Drills.

Fern's "Challenge" Sharpener for Rock Drills. An illustrated description of the machine and its operation. 1200 w. Engng —Oct. 23, 1903. No. 58734 A.

Shafts.

The Utilization of Cross Sections of Hoisting Shafts (Ueber die Ausmitzung des Querschnittes in Förderschachten). H. Stegemann. A discussion of the various arrangement of cages in circular shafts, in order to utilize the space to the best advantage. 5000 w. Glückauf—Oct. 17, 1903. No. 59134 D.

MISCELLANY.

Antimony.

See Electrical Engineering, Electrochemistry.

Bismuth.

The Metallurgy, Mineralogy, and Utilization of Bismuth. Dr. J. Ohly. Describes processes for the extraction of bismuth, giving information of its occurrence, etc. 1200 w. Min Rept—Nov. 5, 1903. Serial. 1st part. No. 58923.

Diamonds.

The Kimberly Diamond Mines. H. V. Conrad. Illustrations, with brief description of the De Beers Consolidated mines. 500 w. Ir Age—Nov. 19, 1903. No. 59017.

Electro-Metallurgy.

See Electrical Engineering, Electrochemistry.

Flint.

Flint, an Ancient Industry. Robert T. Hill. Brief account of the flint industry in England, with remarks on chalk and flint deposits. 1300 w. Eng & Min Jour —Nov. 7, 1903. No. 58846.

Lead.

Lead Smelting in Spain. Hjalmar Eriksson. Brief description, with illustration, of a plant serving as a general type for that country. 1100 w. Eng & Min Jour—Nov. 14, 1903. No. 59227.

The Rossie Lead Veins. C. H. Smyth, Jr. Notes on these old mines of St. Lawrence County, New York. 3700 w. Sch of Mines Qr—July, 1903. No. 59292 D.

Oil.

See Industrial Economy.

Platinum.

Mining Platinum in Southern Oregon. D. H. Stovall. Brief account of the methods for mining and saving platinum recently introduced. 700 w. Min Rept—Nov. 12, 1903. No. 58966.

Tin.

Tin and Its Occurrence—Mineralogy and Metallurgy. Dr. J. Ohly. Describes the characteristics of this metal and its occurrence in the United States and Alaska in the present article. 1200 w. Min Rept—Nov. 19, 1903. Serial. 1st part. No. 59233.

Zinc.

The Roasting of Zinc Blende (Die Röstung der Zinkblende). F. Kellermann. Describing furnaces for roasting zinc ore and converting the resulting sulphur vapors into sulphuric acid. 1500 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—Oct. 31, 1903. No. 59133 D.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

Acceleration.

Some Notes on Acceleration—Electric v. Steam. P. Walter d'Alton, and Dr. John Mannheim. A comparison of the systems, showing that speed and economy are in favor of electricity. 4400 w. Engr, Lond—Nov. 6, 1903. No. 58907 A.

Accidents.

Railroad Accidents—Year Ending June 30, 1903. Reviews the last bulletin of the Interstate Commerce Commission. 2800 w. R R Gaz—Nov. 20, 1903. No. 59217.

The Board of Trade Inspectors. Editorial review of the important points of report in the last Bluebook of the British Board of Trade. 2000 w. R R Gaz—Nov. 5, 1903. No. 58876.

Administration.

Colonial Railway Administration During Crises. Editorial discussion of the policy adopted by the Queensland Ry. Commissioner during the agricultural crisis of the past year, comparing with that of the New South Wales railway authorities. 2000 w. Engng—Nov. 6, 1903. No. 59005 A.

Disaster.

The Glasgow Train Disaster. Information from the report of Col. H. A. Yorke, in regard to the accident on July 27th. Also editorial. 2500 w. R R Gaz—Nov. 13, 1903. No. 58980.

Per Diem.

The Operation of the Rules for the per Diem Basis of Car Hire. F. A. Delano. Discusses some of the difficulties which have developed in the actual operation of the rules. 2200 w. Pro Iowa Ry Club —Oct. 20, 1903. No. 59060.

Tank Cars.

Requirements for Tank Cars Running Over the Pennsylvania Lines. Extracts covering the important requirements. 1100 w. R R Gaz—Nov. 27, 1903. No. 59268.

FINANCIAL.

Earnings.

New York Central & Hudson River. Showing how operating expenses have consumed gross earnings, giving statistics. Map. 1400 w. R R Gaz—Oct. 30, 1903. No. 58780.

New York, New Haven, and Hartford. Report of earnings, operating expenses, etc., for the last year. 600 w. R R Gaz —Oct. 30, 1903. No. 58782.

Reading Company. A report of earnings and operating expenses. 900 w. R R Gaz—Oct. 30, 1903. No. 58781.

St. Louis Southwestern. Brief report of earnings, operating expenses, etc. 600 w. R R Gaz—Oct. 30, 1903. No. 58783.

MOTIVE POWER AND EQUIPMENT.

Bearings.

Improved Alloys for Car Bearings. Editorial reviewing briefly the history of the development of these alloys, and calling attention to the importance of lead. 1000 w. Ry Age—Oct. 30, 1903. No. 58751.

Brakes.

Fitting the Westinghouse Brake to the Bogies of the Locomotives of the Belgian State Railways. F. Matthei. Describes an arrangement being tried as an experiment upon an express engine. 1600 w. Bul Internat Ry Cong—Oct., 1903. No. 58719 E.

Break-Downs.

Break-Downs. Joseph A. Baker. Discusses the easiest and quickest way of making temporary repairs to a disabled locomotive, with the few tools supplied. 2000 w. Loc Engng—Nov., 1903. No. 58752 C.

Car Lighting.

Railway Carriage Lighting by Incandescent Gas. Particulars of experiments made in France. Summary from articles in the *Revue Générale des Chemins de Fer*, and from *Génie Civil*. Ill. 1700 w. Jour Gas Lgt—Oct. 20, 1903. No. 58712 A.

Cars.

A Flat-Car for Heavy Castings. Illustrates and describes steel under frame flat cars, the largest capacity eight-wheel cars ever built. 600 w. R R Gaz—Nov. 13, 1903. No. 58979.

A New Type of Steel Hopper Car. Illustration with description of a decided departure from any designs in use. Built by the Wellman-Seaver-Morgan Co. 5000 w. Eng News—Nov. 5, 1903. No. 58869.

Hazards of Passenger Cars. An illustrated article considering recent advances in construction. Specially discusses the cars of the Illinois Central, and the Subway cars in New York City. 2800 w. Gunton's Mag—Oct., 1903. No. 58694 C.

Connecting Rods.

See Mechanical Engineering. Steam Engineering.

Couplings.

Automatic Car Couplers (Selbsttätige Kuppelungen für Eisenbahnfahrzeuge). H. Sauer. An account of the various automatic couplers submitted for use on the German railways, the hooks being of the M. C. B. type. Two articles, 10,000 w. Glasers Annalen—Oct. 15, Nov. 1, 1903. No. 59128 each D.

The Substitution of Automatic Couplings for Screw-Couplings. Mr. Weiss, in *Zeitung des Vereines*. Describes a system for the introduction of automatic couplers, discussing matters of construction. 2000 w. Bul Internat Ry Cong—Oct., 1903. No. 58721 E.

Draft.

Experiments with Stacks and Exhaust Pipes. Extracts from a paper by T. H. Symington, presented at meeting of the Richmond R. R. Club. Gives results of experiments made which are of interest and importance in proportioning exhaust nozzles to produce chimney draft in locomotives. 2500 w. R R Gaz—Oct. 30, 1903. No. 58779.

Draft Gear.

The Farlow Draft Gear. Illustrates and describes a new type of draft gear and attachment. 900 w. R R Gaz—Nov. 6, 1903. No. 58872.

Fireboxes.

Concerning Leaky Fireboxes. T. S. Reilly. Considers that the lowering of the percentage of firebox to total heating surface has been carried below desirable limits. General discussion. 10,000 w. Pro W Ry Club—Oct. 20, 1903. No. 59057 C.

Locomotive Boilers.

Special Features in the Design of Locomotive Boilers and Fireboxes. Charles S. Lake. Mr. Lake's third and concluding paper treats of recent advances in firebox construction in America and on the Continent. 2500 w. Engineering Magazine—Dec., 1903. No. 59166 B.

Locomotive Building.

Locomotive Building in Germany. A. von Borries. Illustrates and describes many recent types built in Germany, indicating the character of the engines of different works. 3500 w. Cassier's Mag—Nov., 1903. No. 58894 B.

Locomotive Design.

Recent Progress in the Design of Locomotive Front-Ends. W. F. M. Goss. An illustrated paper considering the distribution of draft, action of the exhaust jet, form of exhaust nozzle, etc., etc. 4500 w. Pro Cent Ry Club—Nov. 13, 1903. No. 59058.

Locomotives.

Canadian Pacific Locomotives from Germany. Illustrated description of a freight locomotive. 600 w. R R Gaz—Nov. 27, 1903. No. 59265.

Eight-Wheel Passenger Locomotive for the 'Frisco System. Drawings, illustrations and description. 500 w. Ry Age—Nov. 20, 1903. No. 59235.

Four-Cylinder Compound Locomotives. Alfred G. de Glehn. A general description of the de Glehn compound as now built, with discussion of the reasons that have conduced to its extended use. 2400 w. Engr, Lond—Oct. 30, 1903. No. 58801 A.

Heavy Freight Locomotive. Illustrated description of the 2-8-0 type of the L. S. & M. S. Ry., with information of interest relating to it. 1500 w. Am Engr & R R Jour—Nov., 1903. No. 58919 C.

Heavy Goods Engine for the Bengal-Nagpur Railway. Illustrating sectional drawings and brief description. 2500 w. Engr, Lond—Nov. 6, 1903. No. 59011 A.

Heavy Pacific Type Locomotives for the El Paso & Southwestern. Illustrated description of heavy engines for fast freight service. 500 w. R R Gaz—Nov. 6, 1903. No. 58874.

Mogul Locomotives for Japan, Kiushiu Railway. Illustration, sectional drawings, and general dimensions, with details of construction. 500 w. Ry Mas Mech—Nov., 1903. No. 58813.

Six-Coupled Express Engine for the Glasgow and South-Western Railway. Illustration, with brief description. 500 w. Engr, Lond—Nov. 13, 1903. No. 59084 A.

Tandem-Compound Consolidations for the Colorado & Southern. Illustrated description. 500 w. R R Gaz—Nov. 13, 1903. No. 58981.

Tandem Compound Express Locomotive—Russian Empire Railways. Explains the conditions for the construction of these machines, and the peculiarities of this design, giving an illustrated description. 2500 w. Engr, Lond—Oct. 23, 1903. No. 58738 A.

Ten-Wheel Locomotive for the 'Frisco. Illustrated description. 500 w. Ry Age—Oct. 30, 1903. No. 58749.

The Heaviest Locomotive Ever Built. Sections, with detailed description of heavy freight engines of the 2-10-2 type, for the A., T. & S. F. Ry. 900 w. Am Engr & R R Jour—Nov., 1903. No. 58917 C.

Two-Cylinder Compound Locomotives for the Wabash. Illustrated description of fast freight mogul engines. Also editorial. 1500 w. Ry Age—Nov. 13, 1903. No. 58942.

Motor Car.

Railway Motor Car for the Paris-Orleans Railway Company. An illustrated description of an experimental car which seems to give satisfaction. 1700 w. Engng—Oct. 23, 1903. No. 58733 A.

Piston Valves.

Handling Piston Valves. Jas. Spellen. The writer's views on the proper handling of piston valve engines. 1200 w. Ry & Engng Rev—Nov. 14, 1903. No. 59014.

Reciprocating Parts.

Disturbing Influences of a Locomotive's Reciprocating Parts. Abstract of a paper by Prof. v. Borries. Considers the disturbances due to the unbalanced moving parts. 6000 w. R R Gaz—Nov. 27, 1903. No. 59267.

Testing Plant.

Locomotive Tests at St. Louis in 1904. Editorial review of the bulletin describing the proposed work. 1500 w. R R Gaz—Nov. 27, 1903. No. 59269.

The Locomotive Testing Plant of the Pennsylvania R. R. at the St. Louis Exposition. Describes the organization and plan of work as set forth in a bulletin issued by the Pennsylvania System. 3500 w. Eng News—Nov. 26, 1903. No. 59261.

Wheel Loads.

Permissible Wheel-Load per Foot of Wheel Diameter and per Inch of Breadth of Railhead. Francis J. E. Spring. From the *Pro. of the Inst. of Civ. Engrs.* Also editorial. On the limits of wheel loadings in railway service. 3000 w. Eng News—Nov. 19, 1903. No. 59024.

NEW PROJECTS.

Arctic.

Arctic Railroading. A. S. Atkinson. Describes the conditions that must be met in railroad construction and operation, and some of the benefits already evident from the construction of the White Pass & Yukon Ry. 1700 w. R R Gaz—Nov. 13, 1903. No. 58983.

Berlin.

Recent Improvements in Railway Stations in the North of Berlin (Les Récent Agrandissements des Gares de la Région Nord de Berlin). An account of terminal improvements with especial reference to the Stettin station. 1800 w. 1 plate. Génie Civil—Nov. 7, 1903. No. 59114 D.

China.

Railway Making in China. Thos. M. Reid. An illustrated account of the Anglo-American development of Chinese transportation facilities. 3000 w. Engineering Magazine—Dec., 1903. No. 59161 B.

Extensions.

Extensions of the Buffalo & Susquehanna Railroad. Elisha Walker. Describes the extensions amounting to about 185 miles to accommodate coal traffic. 1600 w. Eng Rec—Nov. 21, 1903. No. 59206.

Improvements.

London and Brighton Railway Widening. The first of a series of articles describing interesting work in England in connection with widening main lines without interrupting traffic. Ill. 4500 w.

Engng—Oct. 30, 1903. Serial. 1st part. No. 58797 A.

Philippines.

Proposed Railways for the Philippines. Map, with description of the routes of railways surveyed on the island of Luzon. 4000 w. Ry Age—Nov. 13, 1903. No. 58943.

Railroads in the Philippines. An account of the improvements and new lines recommended by United States engineers. 1200 w. R R Gaz—Nov. 27, 1903. No. 59264.

Transcontinental.

The New Canadian Transcontinental Railway. Extracts from a statement of the views of Sir Sandford Fleming on the subject of this new line. 1000 w. Eng News—Nov. 5, 1903. No. 58868.

Trans-Siberian Ry.

Siberia and the Trans-Siberian Railway. Some interesting information in regard to this road and its construction. 700 w. U S Cons Repts, No. 1802—Nov. 16, 1903. No. 58989 D.

PERMANENT WAY AND BUILDINGS.

Blocking.

I. Should Frogs and Guard Rails Be Blocked? J. Harrington. II. Blocked Frogs and Guard Rails. J. L. Dawson. Two short papers discussing this subject. 2000 w. Pro Iowa Ry Club—Oct. 20, 1903. No. 59061.

Exchange Stations.

Railway and Canal Exchange Stations. Mr. Mazoyer. Illustrated detailed description of German interchange stations, and matters relating to them. 2000 w. Trac & Trans—Nov., 1903. No. 58903 E.

Freight House.

New Freight House for the Baltimore and Ohio. Illustrates and describes a large structure being built in Chicago, having features of exceptional interest. 800 w. Ry Age—Nov. 6, 1903. No. 58820.

Hamburg.

The Reconstruction of the Railway Connections in and about Hamburg (Die Umgestaltung der Eisenbahnanlagen in und um Hamburg). H. Caesar. An account of the important changes and reconstruction work which has been done at the railway terminals at Altona and Hamburg. 3000 w. Glasers Annalen—Oct. 15, 1903. No. 59127 D.

Location.

Notes on Railway Location in Forest Country. Moses Burpee. Considers the difficulties, the outfit needed, the methods, etc. 3400 w. Eng Rec—Nov. 7, 1903. No. 58845.

Maintenance.

Railway Maintenance-of-Way. H. J. Sliffer. Considers means of securing the best results with the least expenditure. Also discussion. 6000 w. Jour W Soc of Engrs—Oct., 1903. No. 59273 D.

Paint Shop.

The Essentials of a Modern Railway Paint Shop. W. O. Quest. Discusses the necessary capacity, equipment, etc. 2400 w. Pro Ry Club of Pittsburg—Nov. 27, 1903. No. 59302.

Reconnaissance.

Railroad Reconnaissance. Willard Beahan. Considers the principles and methods of work in determining the route and line. Discussion. 6800 w. Jour W Soc of Engrs—Oct., 1903. No. 59274 D.

Shops.

Enlarged Power Plant of the Chicago, Milwaukee & St. Paul Railway, at West Milwaukee. Especially describes the power plant for the enlarged shops. The machinery is electrically driven, the yards and shops lighted with arc and incandescent lamps. Exhaust steam is used for heating, and compressed air furnished. 2000 w. Eng Rec—Nov. 14, 1903. No. 58960.

New Locomotive and Car Shops. An illustrated description of the shop equipment and buildings of the Pittsburg & Lake Erie R. R., at McKees Rocks, Pa. 2000 w. Am Engr & R R Jour—Nov., 1903. Serial. 1st part. No. 58916 C.

The Oaklawn Shops of the Chicago & Eastern Illinois Railroad. An illustrated detailed description of these shops and their equipment. 5500 w. Eng Rec—Nov. 21, 1003. No. 59203.

Signaling.

Progress of Power Signaling in England. Charles H. Grinling. A review of the nrogress made in introducing automatic signals. The first were on the Liverpool Overhead Electric Railway, in 1893. 1800 w. R R Gaz—Nov. 6, 1903. No. 58875.

Signals and Signaling. George S. Hodgins. The present article gives a historical review of the art of signaling. 3000 w. Loc Engng—Nov., 1903. Serial. 1st part. No. 58753 C.

Three-Position. Separate Home and Distant, and Overlapping Automatic Block Signals. Report presented at meeting of Ry. Sig. Club. 1500 w. Ry Age—Nov. 6, 1903. No. 58819.

Spikes.

Increased Resistance of Spikes to Drawing, Produced by Means of Hard Wood Bushes. W. Fridericia. Report of a section at Stockholm. Explains experimental investigations which seem successful.

2300 w. Bul Internat Ry Cong—Oct., 1903. No. 58718 E.

Station.

The New Union Railroad Station at Washington, D. C. An account of the advantages of the new location chosen, with illustrated general description of the station building. 2500 w. Eng Rec—Oct. 31, 1903. No. 58763.

Terminals.

History of the Grand Central Terminal, New York City. An interesting review of the early history of the New York Central and Hudson River Railroad. 2500 w. R R Gaz—Nov. 13, 1903. No. 58982.

Some Proposed Improvements in St. Louis Terminals. A. P. Greensfelder. Describes work being done and contemplated, at a cost of millions of dollars. 7000 w. St Louis Ry Club—Oct. 9, 1903. No. 59056.

Terminal Necessities. W. M. Prall. Considers the necessities of the service and the difficulties. 4500 w. St Louis Ry Club —Oct. 9, 1903. No. 59055.

Ties.

Timber Treating Plants. W. W. Curtis. Refers to the methods of treatment now in use, especially for railroad ties, and their cost, giving illustrated description of plants. General discussion. 7500 w. Jour W Soc of Engrs—Oct., 1903. No. 59276 D.

The Railway Tie Question. Gives abstracts of reports, addresses and discussion of this subject at the recent convention of the Roadmasters & Maintenance of Way Assn. in Kansas City. 3800 w. Eng News —Nov. 19, 1903. No. 59026.

The Tie Problem. With Special Reference to Concrete Ties. G. H. Kimball. Reviews past practice, discussing the question of unequal settlement because of eccentric pressure, and giving illustrated description of a two-part tie with parts rigidly connected, designed by the writer, made of concrete. The form of construction is given in detail, and advantages stated. Discussion. 1600 w. Jour W Soc of Engrs—Oct., 1903. No. 59277 D.

Tracks.

Delaware, Lackawanna & Western Track Elevation in Newark and Harrison, N. J. Illustrated description of important improvements. 1200 w. R R Gaz—Nov. 27, 1903. No. 59262.

Water Softening.

An Extensive Water Softening Installation. Begins a description of the plants of the Pittsburg & Lake Erie R. R., having a total capacity of 348,000 gallons per hour. 1500 w. Am Engr & R R Jour—Nov., 1903. Serial. 1st part. No. 58918 C.

MISCELLANY.

Argentine Republic.

The Argentine Railroads. Reviews the statistics of railroads as given in a recent volume issued by the Minister of Public Works. Maps. 1200 w. R R Gaz—Nov. 6, 1903. No. 58877.

Contagion.

Prevention of Contagion in Passenger Cars. Leroy M. Yale. Considers the liability of contagion remaining in a car after the departure of the contagious case. 2200 w. R R Gaz—Nov. 20, 1903. No. 59215.

New South Wales.

New South Wales Railways. Editorial review of causes of the deficit of the past year. 1700 w. Engng—Oct. 30, 1903. No. 58800 A.

STREET AND ELECTRIC RAILWAYS

Albula Line.

The Albula Line from Thusis to Saint-Moritz. H. Cox. Read before the Wurtemberg Dist. Soc. An illustrated description of a mountain railway having many bridges, tunnels, and difficult construction work. Map and profile. 2500 w. Bul Internat Ry Cong—Oct., 1903. No. 58722 E.

Brussels.

Brussels Electric Tramways. An illustrated description of the reorganized arrangements of the power supply for these lines. 1600 w. Elec Rev, Lond—Nov. 6, 1903. No. 58999 A.

The Central Station of the Brussels, Belgium, Tramways. Emile Guarini. Illustrated description. 1700 w. Elec Rev, N. Y.—Nov. 14, 1903. No. 58948.

Camden, N. J.

The System of the Camden & Suburban Railway Company. The first of a series of four articles describing in detail the methods of this company. The present article is devoted to a description of the physical condition of the system. Ill. 7300 w. St Ry Jour—Dec. 5, 1903. Serial. 1st part. No. 59457 C.

Comparison.

Tramway or Light Railway. W. Valentine Ball. Considers the relative advantages of the two systems. 4000 w. Trac & Trans—Nov., 1903. No. 58900 E.

Convertible Car.

Novel Convertible Car. Illustrated description of a new car designed by Hermann Romünder, of Bloomsbury, N. J., having novel features. 900 w. St Ry Jour—Nov. 7, 1903. No. 58855 C.

Detroit.

The Detroit Group of Electric Railroads. An account of lines in sharp competition with steam railroads. 2500 w. R R Gaz—Nov. 27, 1903. No. 59266.

Electric Traction.

The Conestoga Traction System. An illustrated detailed description of a comprehensive system serving Lancaster, Pa., and the surrounding country. 4500 w. St Ry Jour—Nov. 7, 1903. No. 58853 C.

Extension.

San Mateo Extension of the United Railroads of San Francisco. An illustrated detailed description of a new line to give high-speed service, its equipment, etc. 3000 w. St Ry Jour—Oct. 31, 1903. No. 58773 C.

Fireproof Cars.

Fireproof Cars on the Central London. Illustrated description of motor cars to replace the locomotives formerly used. 900 w. St Ry Jour—Nov. 7, 1903. No. 58-854 C.

Freight.

Freight Business on Electric Railways. F. D. Hawks, in *The Gateway*. A valuable article, considering also the passenger side, and discussing what business should, and what should not, normally be sought by various classes of transportation lines. 1300 w. Ry Age—Nov. 20, 1903. No. 59236.

Glasgow.

The Glasgow Tramways. An examination of some points brought out in a discussion of the report of the Tramways Committee. 4700 w. Trac & Trans—Nov., 1903. No. 58902 E.

Glasgow and Its Tramways. Editorial discussion of the project of a private company to construct tramways in the vicinity, which is opposed by the Municipal Corporation. 2000 w. Engng—Nov. 27, 1903. No. 59423 A.

High-Speed.

High-Speed Trials on the Berlin-Zossen Electric Railway. Brief review of interesting features in these trials, and the results. Ill. 2000 w. Tram & Ry Wld—Nov. 12, 1903! No. 59248 B.

Incline Railway.

Electric Incline Railway at Mt. Beacon-on-the-Hudson. Frank C. Perkins. Brief illustrated description of a line 2,200 ft. long and having a vertical height of 1,200 ft. 1000 w. Elec, N. Y.—Nov. 11, 1903. No. 58921.

Interurban.

Cincinnati Interurban Development. The first of a series of articles giving an illustrated detailed description of this extensive system and its equipment, with its history. 3500 w. St Ry Jour—Nov. 21, 1903. Serial. 1st part. No. 59210 C.

Some Operating Data on the Wilkes-barre & Hazleton Ry. J. E. Wallace. Illustrates and describes physical features of the road, protection of third rail, new form of shoe, tests, etc. 6000 w. St Ry Rev—Nov. 20, 1903. No. 59243 C.

The Interurban Railway & Terminal Co. Illustrates and describes the lines and equipment of a company operating in and around Cincinnati, Ohio. 5500 w. St Ry Rev—Nov. 20, 1903. No. 59241 C.

Isle of Thanet.

Isle of Thanet Electric Tramways and Lighting Company. B. Pontifex. An illustrated description of the power equipment, and lines. 2700 w. Elec Engr, Lond—Nov. 20, 1905. No. 59360 A.

Jungfrau.

The Jungfrau Railway. An illustrated article showing the progress of this wonderful engineering work, and giving information concerning it. 2300 w. Sci Am—Nov. 21, 1903. No. 59029.

Magnetism.

Magnetism Applied to Traction. William P. Baer. Describes the application to the electric car, explaining the principles upon which it is based. Ills., also discussion. 4800 w. Pro Iowa Ry Club—Oct. 20, 1903. No. 59059.

Montana.

Some Features of the Butte, Mont., Electric Ry. J. R. Wharton. Illustrates and describes the line and equipment. 1500 w. St Ry Rev—Nov. 20, 1903. No. 59-245 C.

Motor Ventilation.

The Heating of Railway Motors. S. T. Dodd and M. C. Canfield. States what has already been done in the way of ventilated motors, and the probable tendency of the development of street-railway motors. 2500 w. St Ry Jour—Nov. 21, 1903. No. 59211 C.

Multiple Supply.

The Multiple Supply Electric Railway System. Describes an attempt to solve the problem of the use of electricity on roads now operated by steam, considering also objections to the system which has been tried in Germany. 2400 w. Elec Rev, Lond—Nov. 6, 1903. No. 59000 A.

Newcastle.

Triple-Expansion Engine for Newcastle

Tramways. An illustrated detailed description of a recently completed engine for driving one of the generators. 1400 w. Engng—Nov. 27, 1903. No. 59422 A.

Paris.

The Metropolitan Railway of Paris. Paul Letheule. A fully illustrated account of the building, equipment, and operation of the underground electric railway of Paris. 3000 w. Engineering Magazine—Dec., 1903. No. 59163 B.

The Paris Metropolitan Railway (Die Pariser Stadtbahn). Ludwig Troske. A general account of the Paris underground railway, with maps and profile. Serial. Part I. 4000 w. 1 plate. Zeitschr d Ver Deutscher Ing—Nov. 7, 1903. No. 59106 D.

Power Plant.

Everett (Wash.) Railway and Electric Co.'s New Power Plant. Illustrations, plan and cross-section, with description. 2700 w. Engr, U S A—Nov. 16, 1903. No. 59019 C.

Power Station.

The Underground Electric Railways Power-Station at Chelsea. Illustrations, with historic notes and outline description. 3300 w. Tram & Ry Wld—Nov. 12, 1903. No. 59247 B.

Shops.

Car Shops of the St. Louis Transit Co. Illustrated description of the shops and their equipment. 4000 w. St Ry Rev—Nov. 20, 1903. No. 59246 C.

The Repair Shops of the St. Louis Transit Company. An illustrated detailed description of these extensive shops and their equipment, with editorial. Many new features in labor-saving machinery. 6500 w. St Ry Jour—Nov. 14, 1903. No. 58951 C.

Signalling.

Automatic Signalling on the District Railway. Illustrated description of the first instance in Great Britain of an electric railway automatically signalled by means of track circuits. 2000 w. Engr, Lond—Nov. 27 1903. No. 59428 A.

Single-Phase.

Single-Phase Motors for Tractions. Dr. Giorgio Finzi. A discussion of this system, giving results of experiments, and comparing with other systems. 3000 w. Elec Rev, Lond—Nov. 6, 1903. Serial. 1st part. No. 58998 A.

Speed.

The Speed of Tramcars. Reviews the laws which govern speed in England. 1200 w. Engr, Lond—Nov. 6, 1903. No. 59010 A.

Stray Current.

Electrolysis Investigations at Richmond. Review of the Report of Dabney H. Maury, made after an examination of 101 lines of pipe. 1600 w. Eng Rec—Nov. 7, 1903. No. 58836.

Surveys for Electrolysis, and Their Results. D. H. Maury. Suggestions useful to superintendents of water-works whose duty it is to see that pipes are not destroyed. 5700 w. Am Gas Lgt Jour—Nov. 23, 1903. No. 59214.

Surface Contact.

Surface Contact Tramways at Wolverhampton. Illustrates and describes the Lorain system to be introduced on the new lines to be constructed, giving also facts regarding the advantages claimed. 2700 w. Tram & Ry Wld—Nov. 12, 1903. No. 59250 C.

Third Rail.

Melting Sleet on a Third Rail. W. A. Del Mar. Showing why a large amount of energy is required to heat the rail. 1200 w. Elec Wld & Engr—Nov. 21, 1903. No. 59220.

Tracks.

Reconstruction of Olive Street Tracks in St. Louis. An illustrated account of the reconstruction of an old cable track to an electric track without interfering with the traffic. 700 w. St Ry Jour—Dec. 5, 1903 No. 59458 C.

Trolley Omnibus.

Trackless Trolley in Scranton. An illustrated description of an experimental line recently constructed and under operation. 1700 w. St Ry Jour—Nov. 14, 1903. No. 58952 C.

Vesuvius.

Electric Railroad Up Mt. Vesuvius. Abstract translation from *Revue Generale des Chemins de Fer.* Illustrates and describes a rack rail line. 1100 w. R R Gaz—Nov. 27, 1903. No. 59270.

Vienna.

The Vienna Metropolitan Railway. Emile Guarini. The first of a series of articles giving an illustrated detailed description. 800 w. Sci Am Sup—Nov. 28, 1903. Serial. 1st part. No. 59336.

EXPLANATORY NOTE—THE ENGINEERING INDEX.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language,* together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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CARD INDEX.—**These pages are issued separately from the Magazine, printed on one side of the paper only, and in this form they meet the exact requirements of those who desire to clip the items for card-index purposes. Thus printed they are supplied to regular subscribers of THE ENGINEERING MAGAZINE at 10 cts. per month, or $1.00 a year; to non-subscribers, 25 cts. per month, or $3.00 a year.**

THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w,* a bi-weekly, *s-w,* a semi-weekly, *m,* a monthly, *b-m,* a bi-monthly, *t-m,* a tri-monthly, *qr,* a quarterly, *s-q,* semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* Boston.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Jl. of Science. *m.* New Haven, U.S.A.
American Machinist. *w.* New York
American Shipbuilder. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. d Ing e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *qr.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Sydney.
Autocar. *w.* Coventry, England.
Automobile. *m.* New York.
Automobile Magazine. *m.* New York.
Automotor & Horseless Vehicle Jl. *m.* London.
Beton und Eisen. *qr.* Vienna.
Brick Builder. *m.* Boston.
British Architect. *w.* London.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bulletin American Iron and Steel Asso. *w.* Philadelphia, U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. Soc. Int. d Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Montreal.
Canadian Mining Review. *m.* Ottawa.
Cassier's Magazine. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Electrical Engineer. *w.* London.
Electrical Review. *w.* London.

Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Electrochemical Industry. *m.* New York.
Electrochemist and Metallurgist. *w.* London.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Chicago.
Engineering. *w.* London.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penna. *m.* Pittsburg, U.S.A.
Feilden's Magazine. *m.* London.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland, U. S. A.
Gas Engineers' Mag. *m.* Birmingham.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e. d. Str. Ferr. *w.* Rome.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Ice and Refrigeration. *m.* New York.
Ill. Zeitschr. f. Klein u. Strassenbahnen. *s-m.* Berlin.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron and Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. Am. Foundrymen's Assoc. *m.* New York.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Journal of Sanitary Institute. *qr.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery *b-m.* Fort Monroe, U.S.A.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U.S.A.
Locomotive. *m.* Hartford, U. S. A.
Locomotive Engineering. *m.* New York.
Machinery. *m.* London.
Machinery. *m.* New York.
Madrid Cientifico. *t-m.* Madrid.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Metallographist. *qr.* Boston.
Metal Worker. *w.* New York.
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* City of Mexico.
Minerva. *w.* Rome.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci Press. *w.* San Francisco.
Mining Reporter. *w.* Denver, U. S. A.
Mitt. aus d Kgl Tech. Versuchsanst. Berlin.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Modern Machinery. *m.* Chicago.
Monatsschr. d Württ. Ver. f. Baukunde. *m.* Stuttgart.
Moniteur Industriel. *w.* Paris.
Mouvement Maritime. *w.* Brussels.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *m.* New York.

Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Nineteenth Century. *m.* London.
North American Review. *m.* New York.

Oest. Wochenschr. f. d. Oeff Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg- & Hüttenwesen. *w.* Vienna.
Ores and Metals. *w.* Denver, U. S. A.

Pacific Coast Miner. *w.* San Francisco.
Page's Magazine. *m.* London.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. St. Louis R'Way Club. *m.* St. Louis. U. S. A.
Progressive Age. *s-m.* New York.
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane. Australia.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago
Review of Reviews. *m.* London & New York.
Revista d Obras. Pub. *w.* Madrid.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Gen. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York
Sibley Jour. of Mech. Engng. *m.* Ithaca, N. Y.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens' Institute Indicator. *qr.* Hoboken U.S.A.
Stone. *m.* New York.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago.
Tijds. v h Kljk. Inst. v Ing. *qr.* Hague.
Traction and Transmission. *m.* London.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining. Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
Wiener Bauindustrie Zeitung. *w.* Vienna.
World's Work. *m.* New York.
Yacht. *w.* Paris.
Zeitschr. d. Mitteleurop. Motorwagen Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a S.
Zeitschr. f. Electrotechnik. *w.* Vienna.

CURRENT RECORD OF NEW BOOKS

Note—Our readers may order through us any book here mentioned, remitting the publisher's price as given in each notice. Checks, Drafts, and Post Office Orders, home and foreign, should be made payable to THE ENGINEERING MAGAZINE.

Calendar.

A Calendar of Invention and Discovery. Compiled by John Cassan Wait. Size, 6 by 4½ in.; pp. 770; illustrations, 12. Price, pocket-book form, cloth, $1; wall or desk form, 60 cents. New York: McGraw Publishing Co.

Each page of reading matter of this calendar contains brief biographies of two persons who have made notable contributions to the industrial progress of the world, and gives a short account of the discoveries or inventions made or other great work done by them. Besides this, there are appropriate poetical selections and a chronological list of some of the important events connected with the invention or discovery described. Opposite each printed page is a blank one for memoranda and diary. There are indexes of persons, of things described and of the poetical quotations, so that the calendar becomes a handy book of reference. By the arrangement of the matter, a great deal of valuable information is imparted in an interesting and agreeable manner, and for this reason and also as a convenient and entertaining diary and calendar it will appeal with particular force to those who are doing the progressive work of the world.

Engineering Age.

The New Epoch as Developed by the Manufacture of Power. By George S. Morison. Size, 7 by 5 in.; pp. 134. Price, 75 cents. Boston and New York: Houghton, Mifflin & Co.

The late Mr. Morison was pre-eminently qualified to be a leader in the engineering age which is now beginning, or rather, which has now begun. He was not only a trained technical man, who designed and carried out some of the great engineering works of the present generation, but he was also a man of broad and liberal mind, able to appreciate the work of men of other callings and to take that comprehensive view of the world and its varied activities, which finds expression in the present interesting and suggestive little volume. "The general idea which runs through the book was first suggested to the author while reading his classmate John Fiske's work entitled 'The Discovery of America,' in which the series of ethnical periods among prehistoric men is elaborated. The fact that the world is now entering on a new epoch of the same nature is the fundamental idea of the writer." This idea was developed and enlarged upon in several addresses and an essay, which have been recast to form some of the chapters of the present book. Other chapters are substantially new, and the whole manuscript was completed in the early part of 1898, but, owing to several causes, publication was delayed until after Mr. Morison's death, which occurred rather suddenly last July. The "new epoch" is characterized by the ability of man to manufacture power. The manufacture of power is more far reaching in its effects than any of the great steps of civilization which preceded it. It is exerting the most profound influence in every department of human activity, and when its age is firmly established we shall have practically a new world, in which the quickening and controlling spirit will be that of the engineer.

Geography.

American History and Its Geographic Conditions. By Ellen Churchill Semple. Size 9 by 6 in.; pp. 466; maps. Price $3. Boston and New York: Houghton, Mifflin & Company.

The relation of history to physical conditions is too often overlooked, and events which are assumed to be due to political actions might far better be traced back in many instances to geographical reasons. Taking this viewpoint of the development of the United States, Miss Semple has prepared a very interesting and valuable work, one which will bear careful reading and study. Starting with the settlement on the Atlantic coast, the influence of the rivers upon early exploration and settlement is considered, modified as it necessarily was by the Appalachian barrier. Following upon the period of settlement, the influence of geography upon the operations of the war of 1812, and upon the expansion into the far West is shown to have been most marked, while the relation of geography to immigration, to the location of cities and of railways is included. The effect of the development of the Pacific coast on the growth of the United States as a world power follows, and the line of study thus indicated may aid in examining the direction of future possible development. Each chapter of the book is accompanied with an excellent bibliography, this both adding to its value, and indicating sources for further information. A number of excellent special maps are included.

Lubrication.

Friction and Lubrication. A Handbook for Engineers, Mechanics, Superintendents and Managers. By William M. Davis. Size, 8¼ by 5¾ in.; pp. v, 225; figures, 60. Price, $2. Pittsburg: The Lubrication Publishing Co.

The lubrication of machinery has the greatest influence upon its economical operation, and it is therefore most necessary that those in charge of engines, rolling stock and all kinds of machines should have a proper understanding of lubricants and the best methods of applying them. The present book bears evidence of the first-hand experience of the author, and is written and illustrated in a way which will appeal to practical men. There are sections on the testing of oils; the lubrication of the various parts of steam engines, such as cylinders and valves; the lubrication of gas and gasoline engines, air-compressing machinery, locomotives and railway cars, automobiles, street railway cars, marine engines, mining machinery, refrigerating machinery and textile-fabric machinery; self-oiling bearings; oiling devices and appliances, oil filters and automatic oiling systems; oil house methods, costs, records and tools; and on many other details of lubrication practice which will be found useful to all engaged in the operation of machinery.

Works Management.

The Factory Manager and Accountant. By Horace Lucian Arnold. Size, 9½ by 6½ in.; pp. vii, 431; illustrations, 250. Price, $5. New York and London: The Engineering Magazine.

The vital importance of sound works management is getting to be generally understood, and is acknowledged by all the abler directors and superintendents of manufacturing establishments. But there is still some uncertainty as to the proper methods for securing the highest efficiency and economy, and while the broad lines of factory management are becoming more clearly defined, there is a diversity of opinion as to the details. It is most probable that each establishment must develop the detailed methods best suited to its peculiar needs, but in order to do this successfully and economically, and with the least possible loss of time and energy in experiment, it becomes necessary to learn what has already been done under similar circumstances and to profit by the experience of others. The present book is designed to give just this information, as it describes in detail the actual methods used in some of the most successful American manufacturing establishments. Several complete systems of factory record and accounting forms are given, both the costing and commercial blanks being accurately reproduced in arrangement, and each one having the actual size in inches given, together with its color and the material on which it is printed. The commercial and costing accounting systems are so closely related in the best modern factory practice that neither can be fully and entirely comprehended without a knowledge of the other, and in some instances the same single form is used by both the cost-keeper and the commercial accountant, so that it cannot be fully described without reference to both its functions. The reader is thus enabled to reproduce any form here shown, and apply it in his own practice, and he may also trace its action and effects in relation to the entire accounting of the factory, and can compare his own practice with that of other managers, cost-keepers or accountants. The experienced and successful factory manager is fully aware of the importance of adapting each form blank perfectly to its intended uses, and well knows the tedious and costly experiments which invariably precede that final perfecting of a form before its record of dates and procedures can be made with the least possible clerical labor, while giving the best and clearest summary of performance; and managers who are satisfied with their own methods and results will study with deep interest the means employed by others to obtain similar effects. The manager who is not perfectly satisfied with his system, and who is aware that his accounting costs more than it should, and fails to give information in such complete detail as to clearly point the way to highly desirable savings which he believes possible, cannot fail to find in the present volume hints and examples of the greatest value, showing the exact means by which others have reached the ends he himself wishes to attain.

BOOKS RECEIVED.

Change Gear Devices. By Oscar E. Perrigo. Price, $1. New York: The Derry-Collard Co. London: The Locomotive Publishing Co., Ltd.

Kalender für Elektrochemiker, sowie technische Chemiker und Physiker. 1904. By Dr. A. Neuburger. Price, 4 marks ($1.25). Berlin: M. Krayn.

ASTOR, LENOX AND TILDEN FOUNDATIONS.

THE ENGINEERING MAGAZINE
"THE WORLD IS ITS FIELD"

VOL. XXVI. FEBRUARY, 1904. No. 5.

MINING AND RAILWAY DEVELOPMENT IN PERU.

By G. Fred. Collins.

In considering the commercial consequences of the opening of the Panama Canal, the relations of Europe and the United States to the Pacific coast of North America and to the Far East have been most conspicuous in the public mind. The greatly improved access to the nations of the Pacific coast of South America, however, is very important, and it is certain that among the first commercial results of the piercing of the waterway will be the development of Peru and its neighboring republics. Mr. Collins writes from a large experience gained in many visits to all parts of South America—visits including protracted residence and successful commercial relations; and his observations and his information are all acquired at first hand, and supplemented by many unique photographs.—THE EDITORS.

THE opening of the Panama Canal will be one of the great events in the history of the Western hemisphere, as it will place the Pacific coast of South America in closer communication, by steamers direct, with the United States. Peru, the home of the ancient Incas, from its location, will be one of the first countries to receive benefit from the construction of the Isthmian waterway. Most of the goods shipped to Peru at this time are sent by steamers from England and Germany, mostly from Hamburg. A great many American exports, even, are sent to Hamburg to be reshipped to Peru, the rates of freight being less by this route than by the steamers which leave New York and go around the Horn to Peru, stopping at other ports en route. Europe and the United States will both be vastly nearer to the west coast of South America when the short passage through the Isthmus, from ocean to ocean, is at last finished.

The trip down the coast from Panama on the comfortable steamers now running between that port and Valparaiso is broken by stops at Guayaquil (Ecuador), Payta and Trujillo (Peru), all interesting

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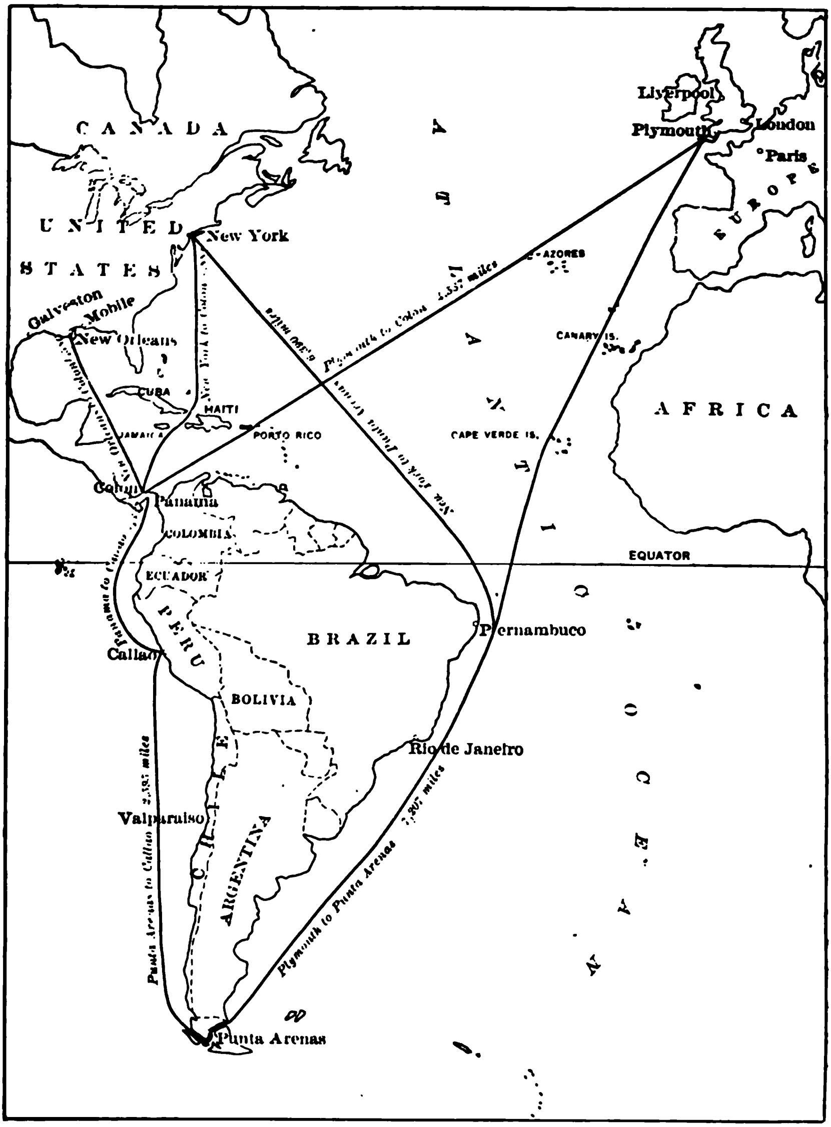


OUTLINE MAP OF (APPROXIMATE) RELATIVE SAILING DISTANCES VIA THE PANAMA CANAL AND THE STRAITS OF MAGELLAN.

It will be noted that the distance from New York to Callao, which is 8,985 miles via the Straits of Magellan, will be reduced to 3,218 miles via the Panama Canal. The distance from Plymouth to Callao will be reduced from 9,802 miles to 5,874. All distances given are expressed in nautical miles.

places. Anchorage in the Bay of Callao is reached generally during the night, and the passenger awakens in the morning to find himself in the chief seaport of Peru. The bay is shut in by the Island of St. Lorenzo, which with its little light house perched high up on one end, looks very commonplace, except when associated with the history of its origin. The island rose from the depths of the Pacific in one night during a frightful earthquake, at which time the old city of Callao was engulfed beneath the waters of the Pacific.

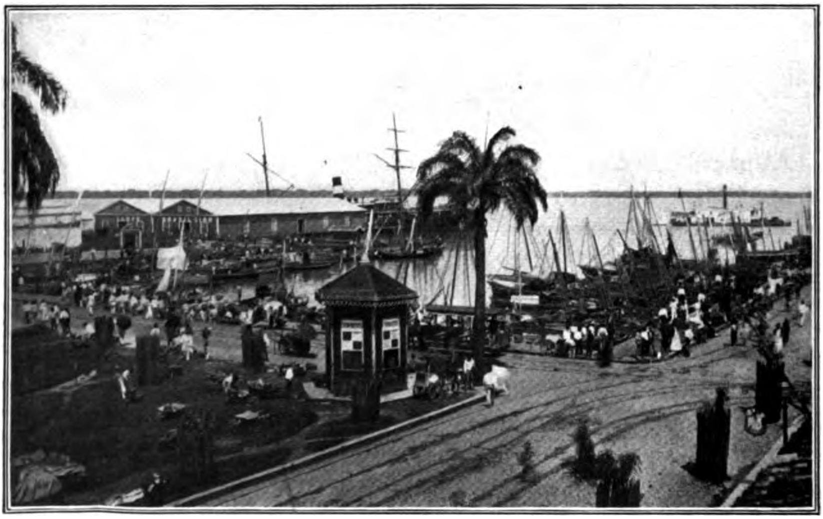
TAKING IN CARGO, PACIFIC COAST, COASTWISE STEAMSHIP.

After passing the custom house at Callao (where one always finds the officials very courteous and polite), passage may be taken by either the English or American Railway for Lima, the capital, which is situated about six miles from the coast; there comfortable accommodations can be found in one of the several good hotels. I must say that in all my experience in traveling through South America, there are no people who give better treatment towards Americans generally than the Peruvians. Their attitude has probably been influenced by the treatment they have received from the United States.

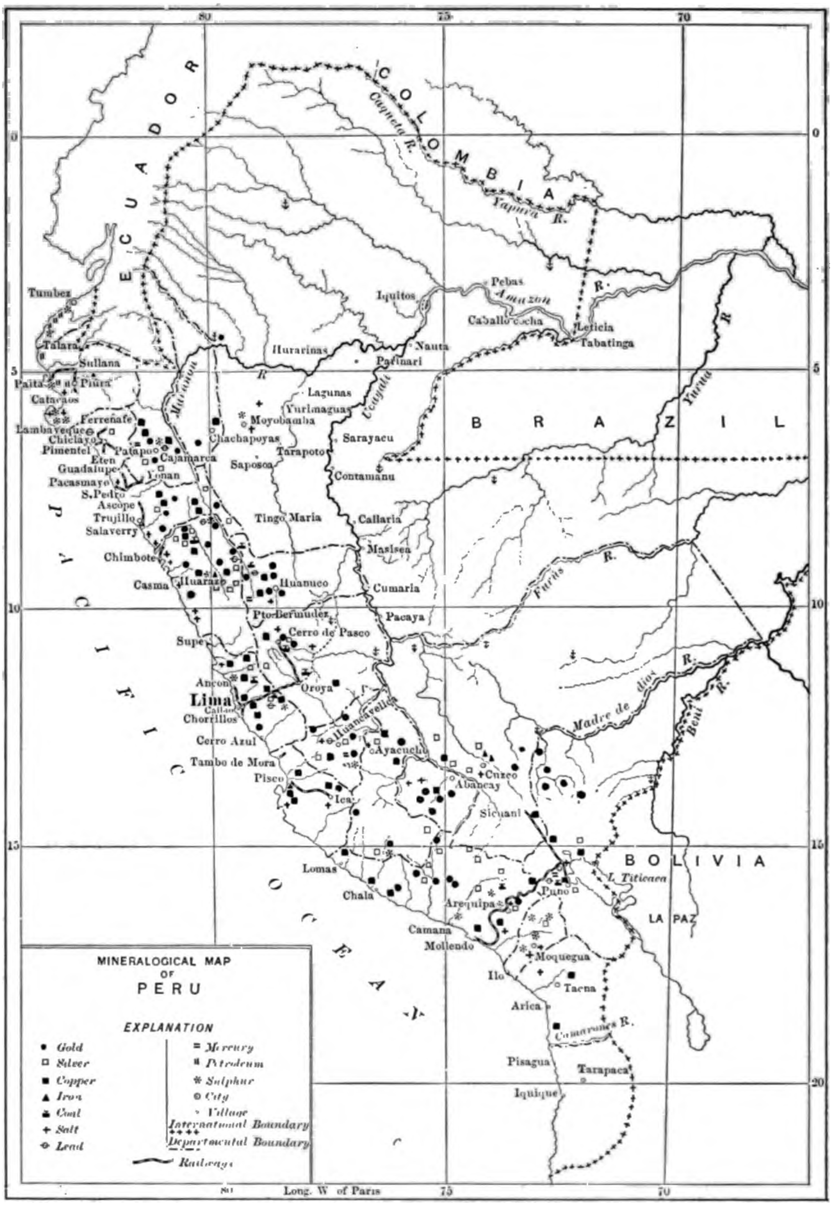
On the west coast, Peru is bounded by the Pacific Ocean, having an extensive coast line of about 1,300 miles. It adjoins on the north the republics of Ecuador and Colombia; on the east, Brazil and Bolivia; and on the south, Bolivia and Chili. The most northern port on the Pacific coast is Tumbez, the first point of landing by the Span-

SHIPPING IN THE HARBOR OF CALLAO.

iards when they came to conquer the country. The boundary line commences a short distance to the north of that port and runs southward as far as the river Macara, following its course to about latitude 5° south, longitude 79° west, whence (according to the line claimed by Peru) it goes in a northeasterly direction by Andoas to Santa Rosa, which is the extreme northern point of Peru. The boundaries between Peru and Bolivia have never been definitely fixed, but it is understood the line follows up the river Beni to the Andes, passing through a

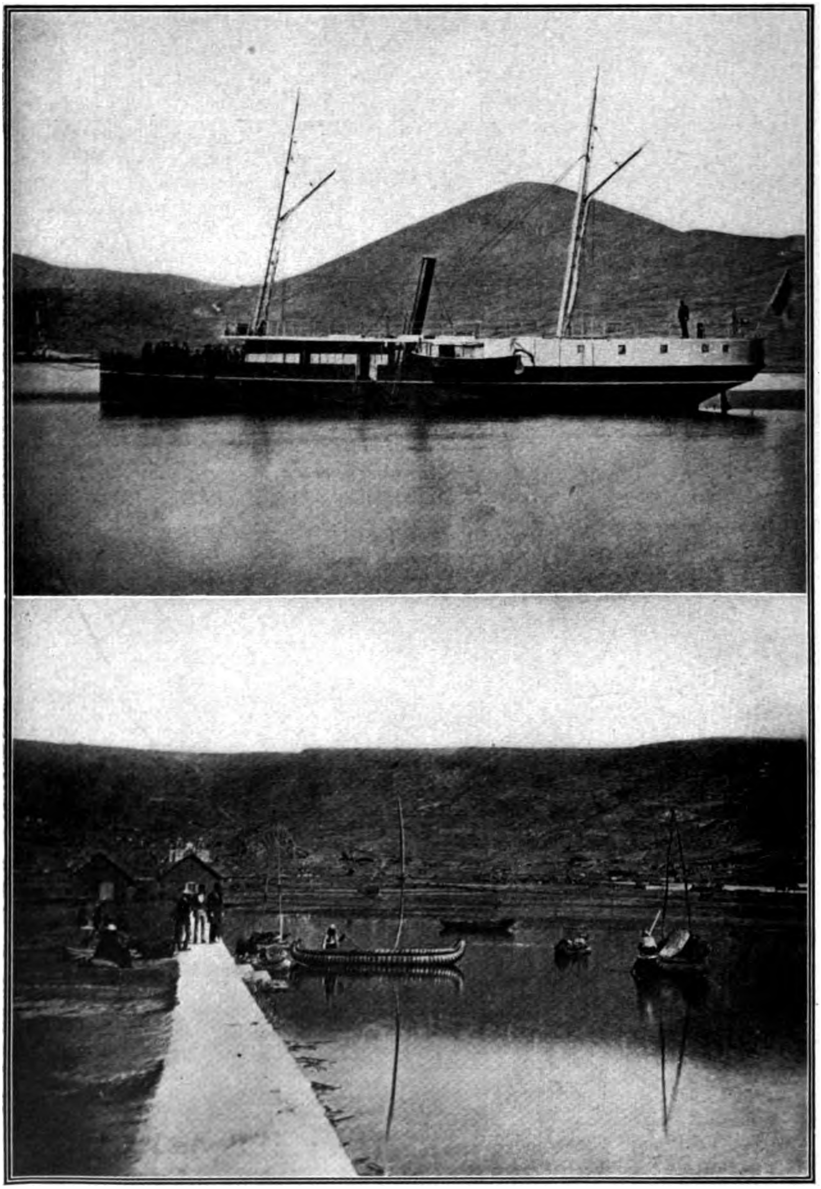


THE PORT OF PARA, BRAZIL, AT THE MOUTH OF THE AMAZON.
The commerce of eastern Peru has a possible outlet by navigable waters of the Amazon to the Atlantic, 3,000 miles from Callao across the continent.



MAP OF PERU, ACCORDING TO A PUBLICATION (1903) OF THE MINISTER OF FOREIGN AFFAIRS.

By this map the northern boundary is pushed out much farther than the line defined by Mr. Collins on page 644. This probably represents the maximum of Peru's territorial claims.



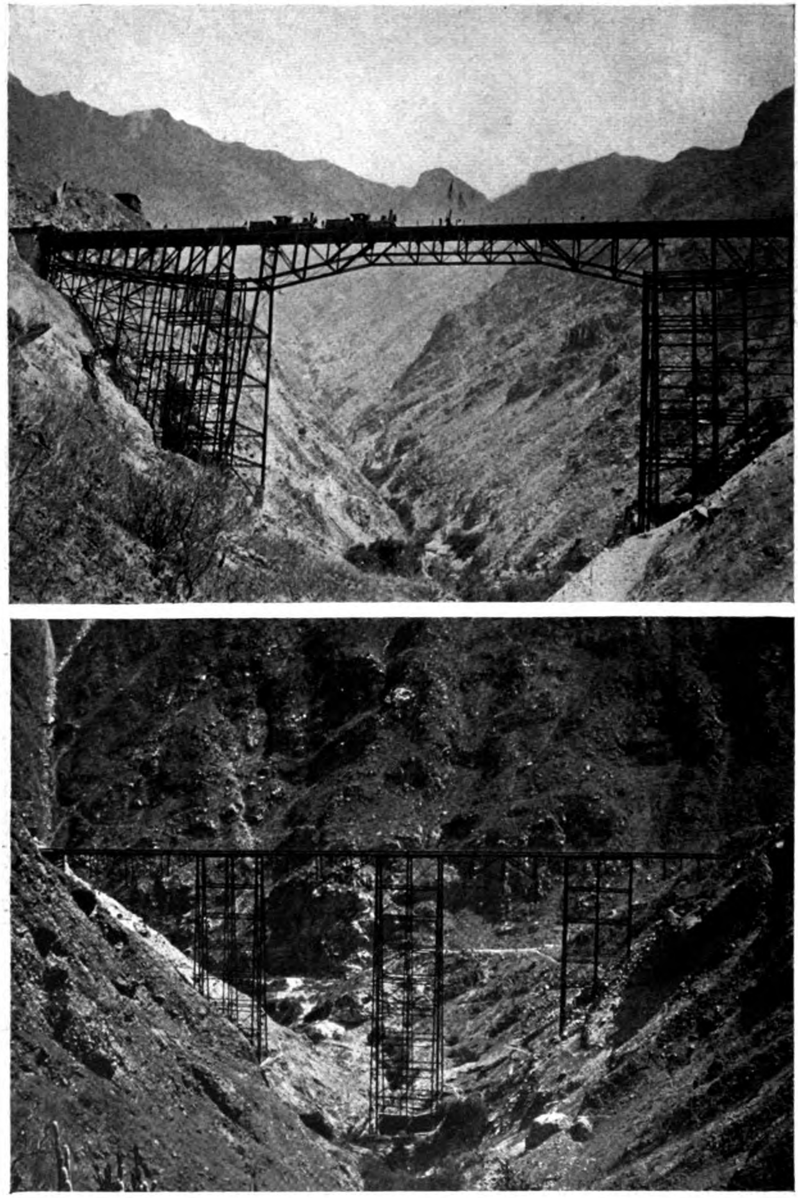
NATIVE AND STEAM CRAFT ON LAKE TITICACA.

The highest body of water in the world navigated by steam. Elevation, 12,545 feet. The only fuel obtainable for the steamboat is dung of the vicuña or guanaco—the llamas of the high altitudes.

THE CITY OF LIMA, FROM SAN CRISTOBAL.

part of Lake Titicaca, and thence follows the Andes till it reaches and descends the river Camarones. The area of the Peruvian territory is about 500,000 square miles, being as large as England, France, Spain and Portugal put together.

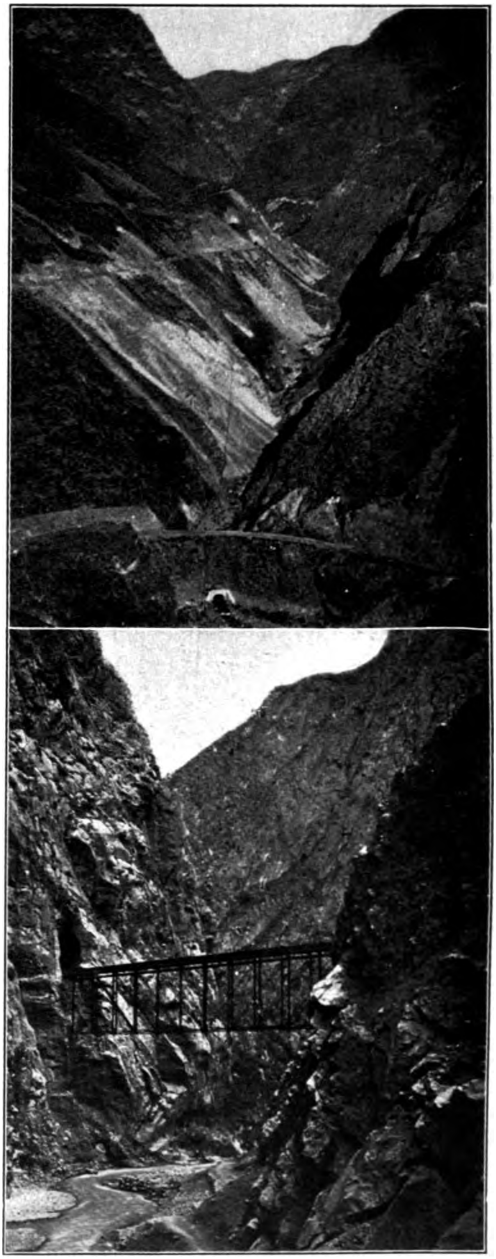
One of the most interesting trips afforded by the present transportation facilities of the country is that over the Oroya Railroad which now runs from Callao to the gold fields of Cerro de Pasco. It is considered one of the wonders in the Peruvian world, and the original contract was taken by Mr. Meiggs at $27,600,000 in bonds at 79. It is certainly the greatest feat of railroad engineering in either hemisphere, and as a specimen of American enterprise and workmanship it suffers nothing by comparison. It was begun in 1870 and finished in 1876, and additional work has since been done on it. Commencing in Callao, it ascends the narrow valley of the Rimac, rising nearly 5,000 feet in the first 46 miles. Thence it goes through the intricate gorges of the Sierras till it tunnels the Andes at an altitude of 15,645 feet, the highest point in the world where a piston rod is moved by steam. The wonder is doubled on remembering that this elevation is reached in 78 miles. One of the most remarkable things in connection with this road is that between the coast and summit there is not an inch of down grade. The difficulties encountered in its construction were extreme—



THE VERRUGAS VIADUCT, BEFORE AND AFTER RECONSTRUCTION.

The lower view shows the earlier form. The cantilever construction was adopted after a flood had taken out the centre pier.

landslides, falling boulders, soroche (or the difficulty of breathing in high altitudes) and verrugas, a disease known only along the line of this road, characterized by a species of warts breaking out all over the body and bleeding. About 8,000 workmen were engaged at one time, and between 7,000 and 8,000 persons died or were killed in the construction of the road. The bridges and crossings, about thirty, are all made of iron or stone; of the metal structures some are of French and some of English manufacture, but the best are American. The Verrugas bridge is one of the most remarkable structures of its kind in the world. It spans a chasm 580 feet wide, and originally rested on three piers. The centre one was destroyed by a water spout, and to prevent repetition of the accident a bridge of cantilever type was constructed to replace the old one, as shown in the photographs. The view was taken during a test of the span.



ON THE OROYA RAILWAY.

LIMA. THE PLAZA AND THE CATHEDRAL.

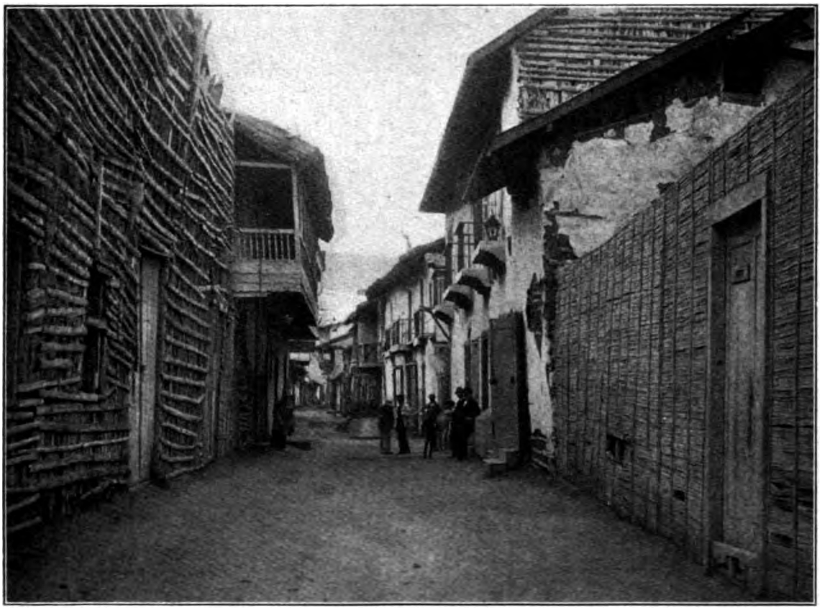
One of the most exhilarating trips is a ride down the Oroya Railroad on a hand car, drawn by gravity; to fly along the edge of a precipice at the rate of 50 miles an hour, and to go around a curve until every hair of your head stands on end, is glorious—when over. I think that one experience of this kind during a lifetime is enough.

American capital is very largely interested in enterprises in Peru, and it is certain to be more so when a line of steamers is established running direct from New York through the Panama Canal to Callao. The wealth of Peru in precious metals has always been proverbial, and it is sufficient to consult the ancient historians to get some idea of the quantity of gold which the country was reported to possess. The existence of great wealth in the precious metals is shown by the objects of art which were found in the temples of the Incas at Cuzco, Pachacamac, and other places, at the time of the conquest, and also the large amount of gold which Atahuallpa gave for his ransom, at Cajamarca—a room, historians tell us, filled with gold as high as one could reach. Several times during my travels in Peru I have seen men with bottles of gold nuggets which they had found in some of the river beds. The country in the extreme eastern portion of Peru on the rivers forming the headwaters of the Amazon, is, however, very dangerous to white men on account of unhealthy conditions and climate and the prevalence of fevers. The natives also are unfriendly and treacherous.

Silver and copper are mined in large quantities, and the coal deposits of the Ancachs department are among the richest in the world. It seems as if nature had designed to give the country, at the same time she endowed it with its magnificent metal mines, the most useful element to enable it to draw profit from them.

There is no question but the output of gold and silver can be very much increased when better facilities are provided by the influx of capital and talent which will follow the establishment of direct communication with the United States and closer touch with England and the Continent.

The necessity for a thorough geological survey, similar (say) to that of the United States, is great, and the mineral wealth it would disclose is unquestionably enormous. The Peruvian Government is actively awake to the opportunities and the needs of the country and is making an earnest effort to put the facts before the engineering and financial interests of the older countries. "Mining in Peru is still in its infancy," says the Minister of Foreign Affairs in a recent publication, "and foreign enterprise is needed, as native capital is insufficient for such great undertakings." "It may be said that the greater part of the mineral products of Peru is exported; very little of it is used in the country, with the exception of small quantities of gold and silver for the mint, and for the manufacture of ornament, etc., and of coal,



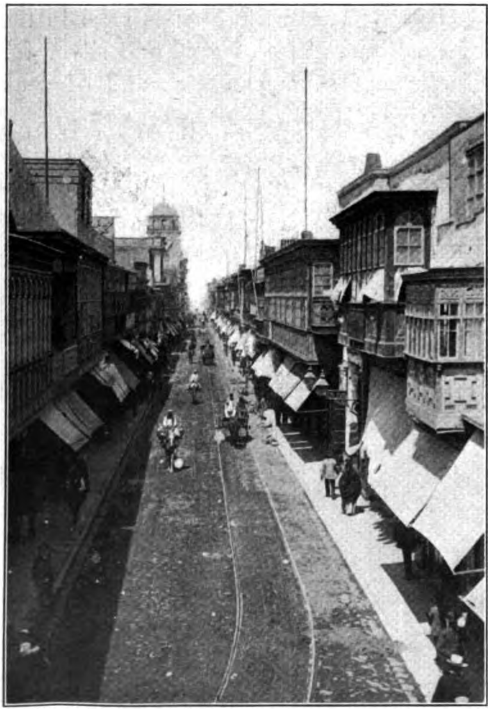
MAIN STREET, PAYTA, A NORTHERN COAST CITY OF PERU.

petroleum, salt for domestic uses, and of quicksilver which is employed in amalgamation works." He summarizes the total mineral output of the country in 1900 and 1901 in the following table:—

	Kilogrammes.		Soles.	
	1900	1901	1900	1901
Gold	5,418	6,994	2,232,000	2,500,000
Silver	26,108,015	21,368,352	9,295,755	7,000,000
Copper	35,500,000	25,172,826	6,192,615.36	10,252,500.63
Lead	218,933	114,407	85,116.67	50,123.02
Mercury	11,500	....	17,500	
Coal	47,500,000	45,000,000	650,000	600,000
Graphite	11,909	....	1,613	
Sulphur	634	4,120	31.76	412
Borax	7,079,714	4,156,047	566,377.12	332,483.46
Salt	15,000,000	15,849,111	550,000	784,764.20
Sundry	145,551	....	39,597.50	157,948.94
	131,581,673	111,671,860	19,630,606.35	21,678,323.25

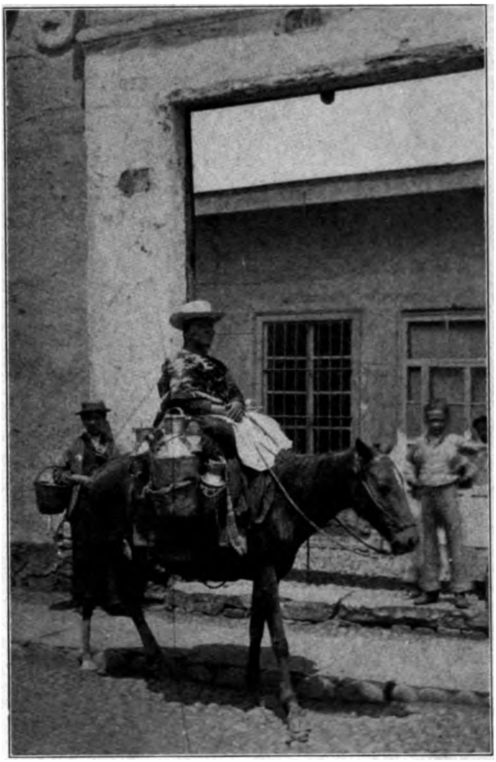
The value of the "sol" is about 24 pence, or 48 cents U. S. currency.

A question of vital importance to outside enterprise seeking opportunity to exploit the undeveloped wealth of Peru would, of course, be the attitude and policy of the Government toward the mining industry. Señor Larrabure y Unanue, the Foreign Minister, thus defines the law and practice of his country:—



A STREET IN LIMA.

> The mining industry is open to all, irrespective of nationality. The usual mining claim, or "pertenencia," allowed by the State, is 100 metres in width and 200 metres in length, measured horizontally "in the direction pointed out by the person interested" and extending vertically to indefinite depth. A claim double this size (or four hectares) is allowed in the case of coal, petroleum, and placers of platinum and tin. The maximum of a concession is limited to 70 contiguous pertenencias, but the law does



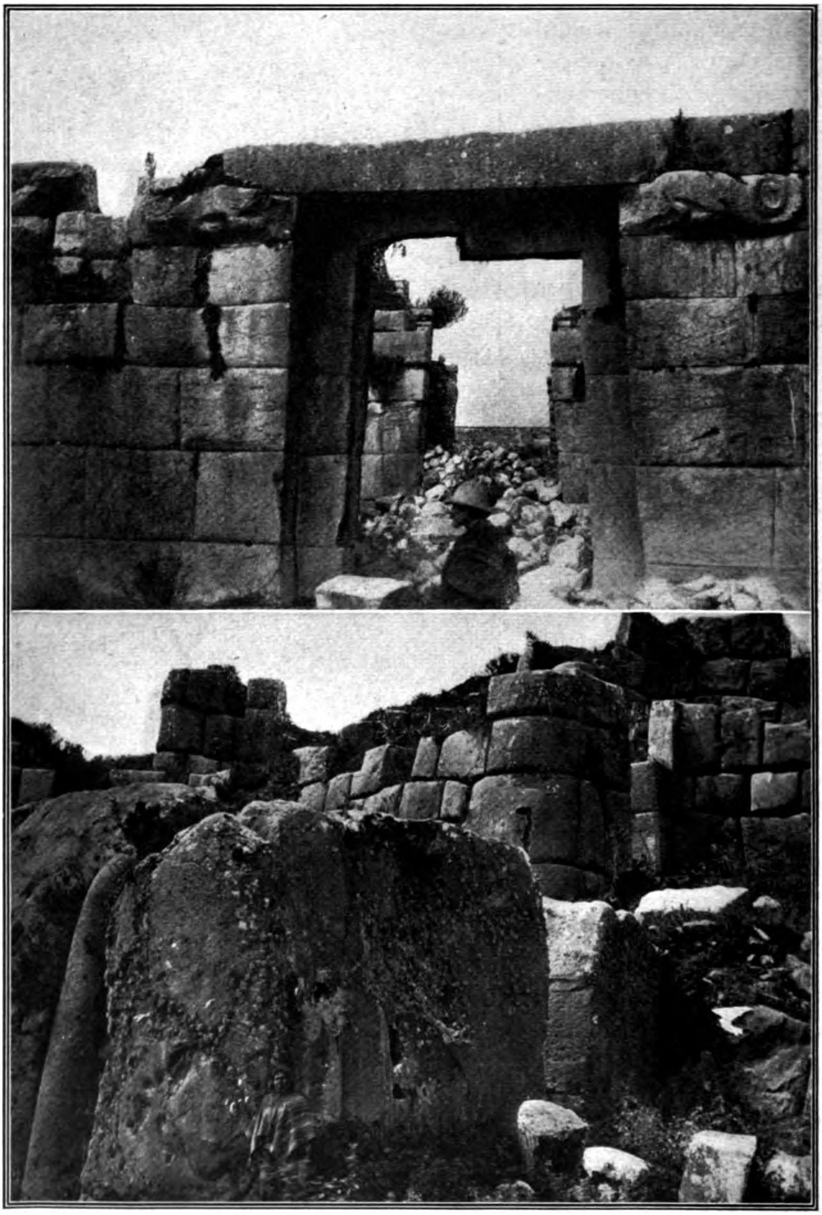
IN THE STREETS OF LIMA.

not prohibit one person from soliciting several grants which are in close proximity to one another. The only tax, except one of 3 per cent. on the exportation of gold in bars and in gold dust, is of 15 soles ($7.50, or £1.10) per pertenencia every six months; miners may transfer their rights, or part of them, without objection. By a law passed November 8, 1890, no new taxes can be imposed on the mining industry or on the exportation of metals for the space of twenty years.

In the mining centres the miners elect their own "special representatives," familiar with all mining questions, foreigners being eligible to such election. The laws afford all facilities and proceedings are simple and rapid.

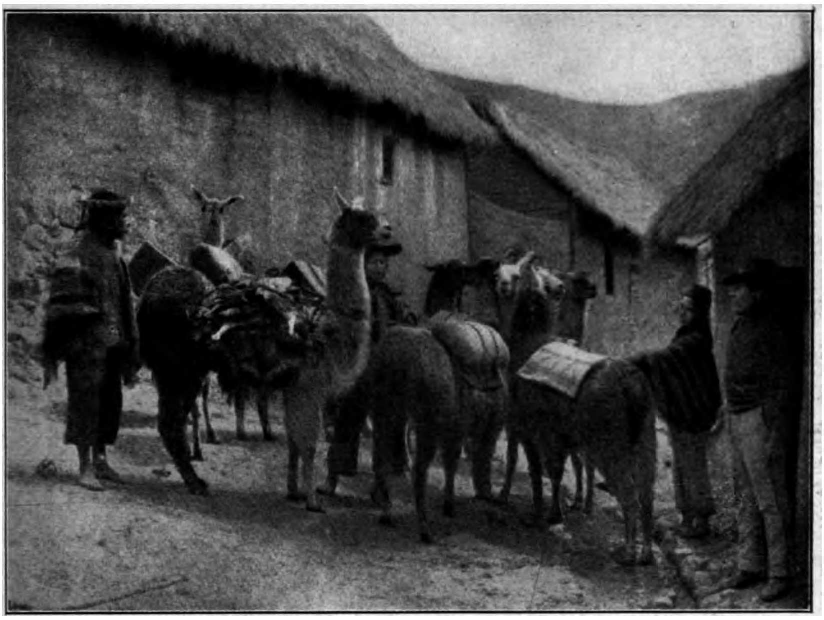
There are no other restrictions, except that guano deposits are Government property, and nitrate, borax, and other alkaline salt deposits are subject to special laws. The total number of pertenencias taken up was, in 1880, 1,756. By 1890 this had risen to 3,490, and in 1900 the number had reached 5,178. An idea of the distribution of the mineral wealth is given by the map.

The railway enterprises in Peru are practically at a standstill at the present time. There is however already invested about $150,000,000 in railroads—a large sum for a population of about 4,000,000 people. Almost all the great railroads of the Republic represent the work of Mr. Meiggs, one of the most active representatives of engineering enterprise south of the equator. Mr. Meiggs had contracts with the Government amounting to $133,000,000, for building seven rail-



ANCIENT RUINS AT CUZCO, ONCE THE CAPITAL OF THE INCAS.

The stone behind the Indian in the lower picture is estimated to weigh 360 tons.



TRANSPORTATION IN PERU. LLAMA PACK TRAIN, EN ROUTE TO CUZCO.

roads with an aggregate length of about 1,000 miles. The gauge of the roads is 4 feet 8½ inches, except in the case of that at Chimbote, which is 3 feet. The rolling stock is American, cars coming principally from Gilbert Bush & Co., Troy, N. Y., and locomotives from Rogers, of Paterson, N. J. A locomotive on the track costs about $20,000 to $25,000, and the first-class car $5,500.* The ties are from Oregon, the rails from England, and the diamond drills from America, worked by Rand compressors. The stationary machinery has been imported largely from Leeds, England. The shops and stations generally are made of galvanized iron. The shovels are Ames, and the iron water tanks Pills' patent. The engineers, at least those I met, are invariably English-speaking, and the laborers are Chinese, Cholos, and Chilians. The timber, iron, rolling stock, labor, and fuel, and nearly all of the food, are imported. The train upon which I went over the Oroya road was drawn by a locomotive using crude oil. I rode on the engine over almost the entire system and found that the oil was giving great satisfaction.

I once made a trip up to Cuzco, the ancient capital of the Incas, and there saw the noted fortress of Sacsahuaman, the beauties of which have been described by Squiers in his work on Peru. The photographs which are reproduced on page 654 show the size of some of the stones; the one in front of which the Indian is standing is estimated to weigh about 360 tons. It was brought from the quarries about 17½ miles distant, and elevated to the fortress, which is about 800 feet above the town of Cuzco. The Incas must have been able to handle such tremendous weights by methods which have been lost. Unfortunately, a great many of the finest buildings were destroyed by the Spaniards, so that we simply have the ruins to show us what great buildings were originally erected.

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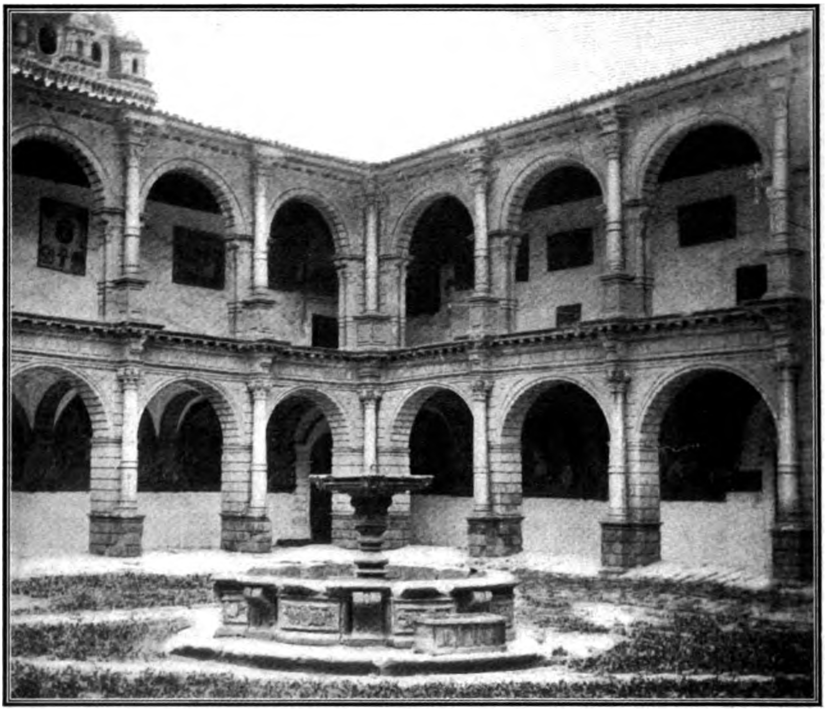
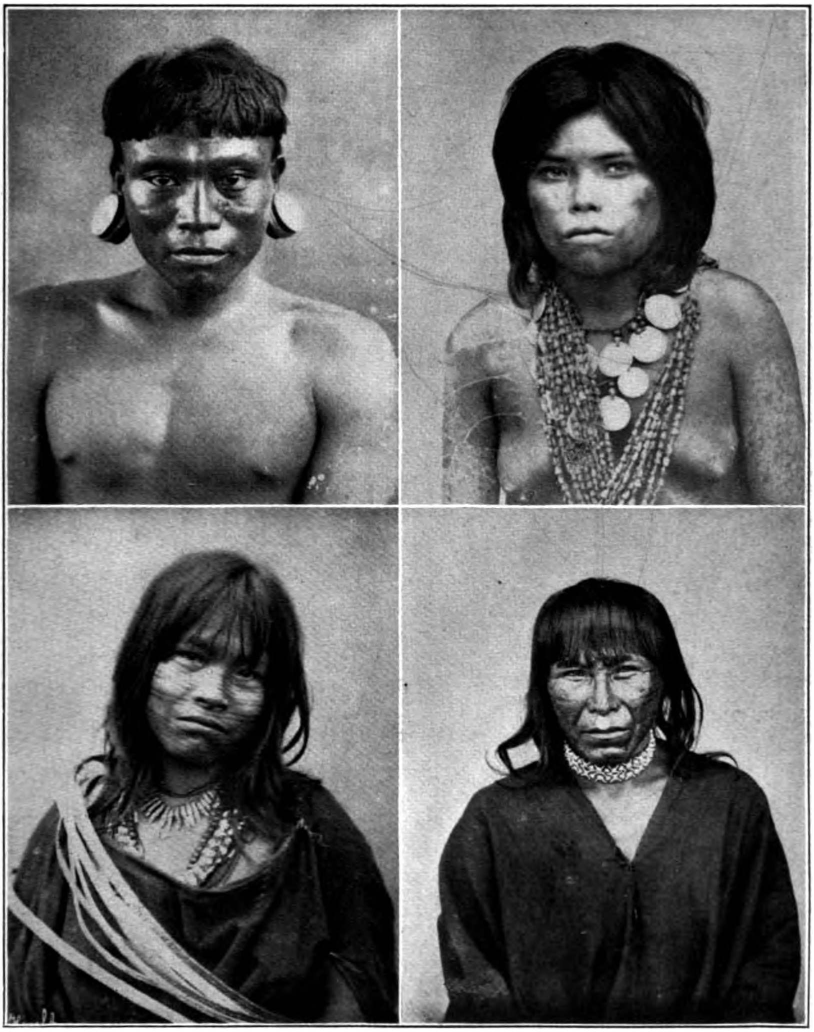
* The prices are in American gold coin.



CLOISTERS OF THE CATHEDRAL OF CUZCO, BUILT ON THE SITE OF THE ANCIENT TEMPLE OF THE SUN.

The stone which now forms the basin of the fountain in the centre was the altar on which human sacrifices were offered in the time of the Incas.

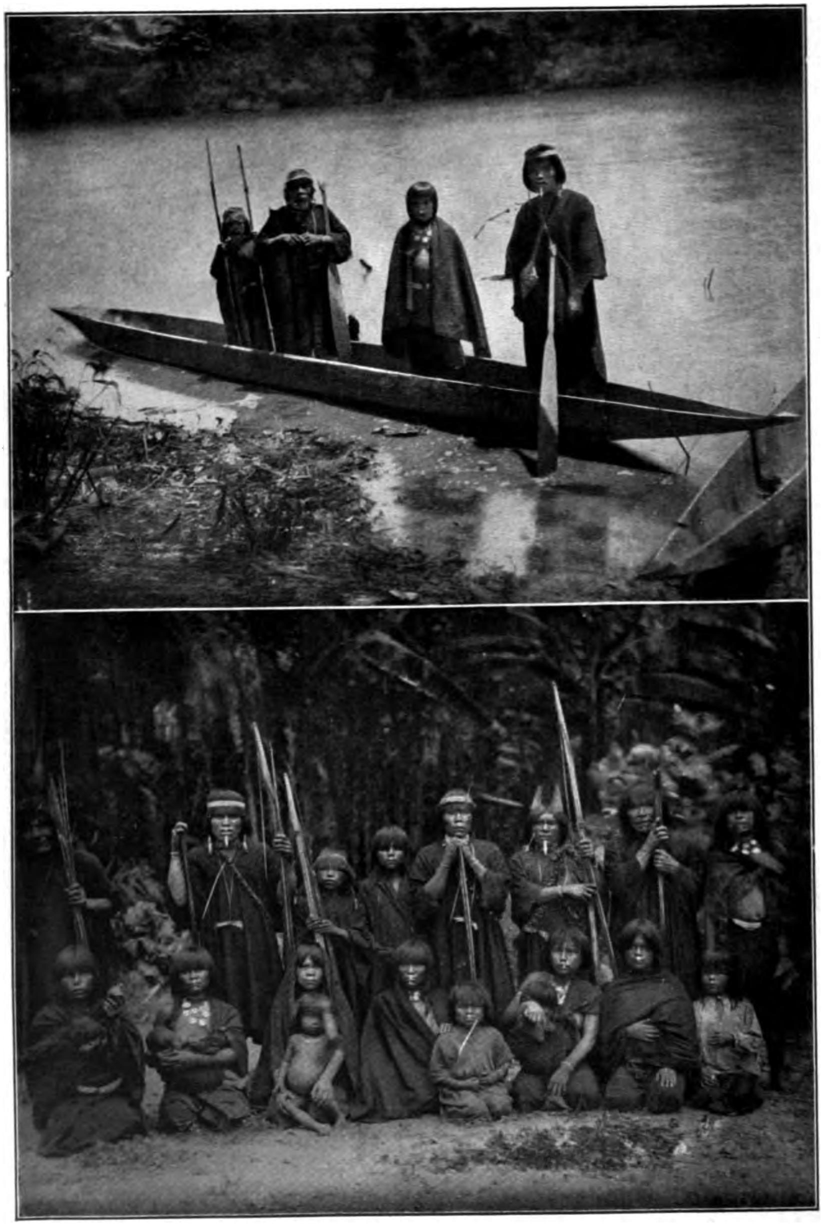
Most interesting subjects for study are found in the various tribes of Indians which occupy the region in the extreme eastern part of Peru, at the headwaters of the Amazon River. The Marugas on the Javary have a dark complexion and light beard; on the west side of the river are the Mayorunas, a fierce, hostile, light-colored tribe of bearded cannibals. The Conibos occupy the extreme north of the territory of the Huillcamayo and part of the prolongation of the Ucayali; the extent



INDIANS OF THE UPPER AMAZON BASIN, PERU.

1. **Orejon.**
2. Campa.
3. Cashiva (cannibal).
4. Conibo.

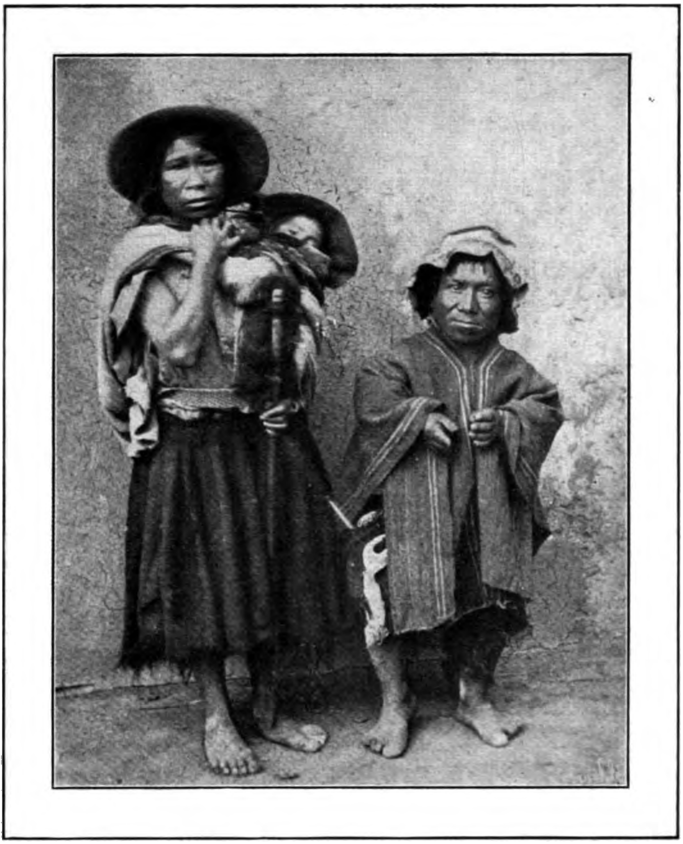
of their territory is 246 miles, beginning at the river Simpa and extending to the Capisinia. The land is flat and woody and the atmosphere is humid. The Conibos are small in stature, brown in color; their bodies are fat and almost womanish; their features are proportionate, and they have their noses less flattened than other Indians. The women have ugly faces, and deformity in proportions of the body. The



CONIBOS (OR CUNIBOS) INDIANS OF THE UCAYALI RIVER.

Orejon Indians have a peculiar way of putting round discs in their ears, considering it a decoration of beauty.

The Cashiva Indians live on Chonta Island, in the Rio Pachitea; they are cannibals. The decorations seen around the neck of the girl in the illustration are silver soles, or Peruvian dollars. They probably have been stolen from some traveller.



AN INDIAN (DWARF) AND FAMILY—CAJAMARCA.

Professor Orton says: "The valley of the Amazon is probably the most sparsely populated region on the globe. There are not 40,000 souls along the banks of the rivers in the whole of the Amazon and the Maranon. Many of the towns marked on the map do not exist, or are represented by a solitary palm hut. The visible population is almost confined to the circumference of the valley, as at Para at the mouth of the river, at Moyobamba and at Tarapoto. The great basin is filled

AN INDIAN VILLAGE.

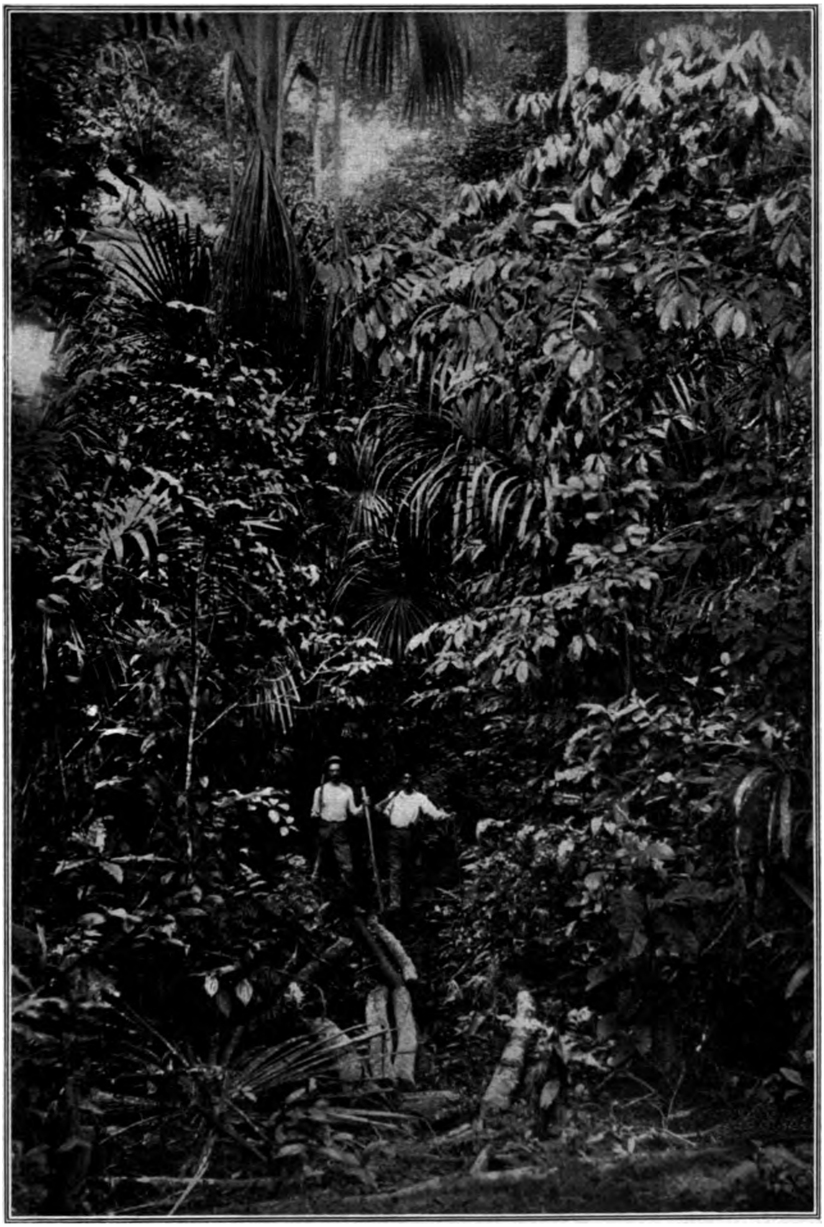
with a continuous, dark, primeval forest, rarely disturbed by the hand of man, and into which daylight seldom enters. Yet imagination peoples this pathless wilderness with uncounted forms of savages. There are, it is true, numerous clans—we can hardly call them tribes—which, though dignified with separate names, are insignificant in numbers, barely numbering 100 each.

"Raimondi puts down the number of all the wild Indians on the Maranon (that is, in the whole province of Loreto which stretches from Ecuador to Cuzco and from the top of the Andes to Brazil), as from 30,000, to 40,000. To this must be added another 40,000 to include the civilized tribes, half castes and whites."

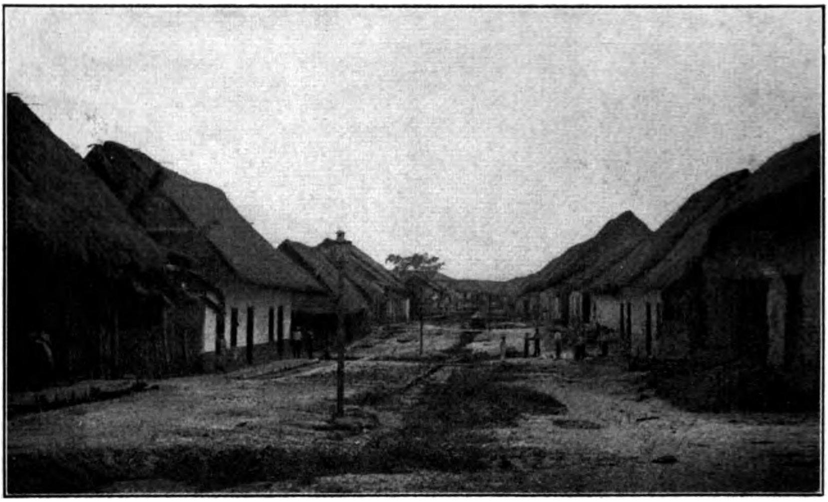
Authors assign to South America from two hundred and eighty to seven hundred languages, of which two-fifths are composed of idioms radically distinct. The polygot America is antipodal to the Chinese. The language of the latter is richer in words, that of the former, the poorer. The preposition follows the noun, and the verb ends the sentence.

TYPE OF THE LORENZO INDIAN.

The hospitality of the Peruvian people is acknowledged by all who have visited Peru. They are also very charitable, as testified by the numerous institutions supported by voluntary contributions. The Peruvian women are well-known for their do-

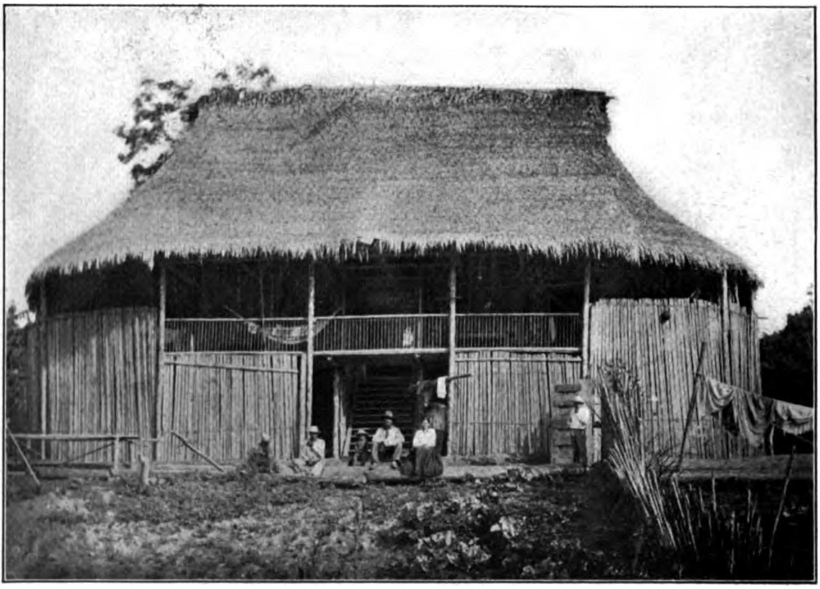


A "ROAD" IN THE PERUVIAN FOREST, AT THE HEADWATERS OF THE AMAZON.



STREET IN PERUVIAN TOWN. CALLE DE BELEN, IQUITOS.

Iquitos, though well within the western boundaries of Peru, near the headwaters of the Amazon, was visited some years ago by the U. S. gunboat Wilmington, in 1899. According to the reconnaissance survey then made, 14 feet draft can be carried to Nauta at any time. (See map, page 645.)



HOUSE OF A GERMAN SETTLER, RIO PACHITEA.

The family have since been killed by the Indians, and the house destroyed.

mestic attachment and patriotism. Their merits were displayed during the late war with Chili, when they make great sacrifices for their country's sake, giving up not only their money but their jewelry and other valuables. Much has been said, with very good reason, of the beauty of the ladies of Lima. In addition to their unimpeachable morals, they can count amongst them numbers of high literary celebrities. Nature has lavishly endowed them with many of her choicest gifts. In figure they are usually slender and rather tall, and they are especially remarkable for small, elegantly formed feet. Their fair faces are animated by large, bright, dark eyes; their features are pleasing, the nose being well formed, though in general not small, the mouth invariably adorned with brilliant white teeth, and the long black hair arranged in plaits falling gracefully over the bosom and shoulders; add to all this a captivating grace of manner and deportment, joined to an exceeding degree of gentleness and amiability, and it will be readily admitted that the Limeña is a gracious specimen of female loveliness.

In all my travels in South America I never found any people who were so anxious and willing to do business with the United States as the people in Peru. Upon the same terms—or even a little more—they seem to be willing to give the United States the preference, and when the Panama Canal is finished, undoubtedly a large business will be done with the American manufacturers in all classes of goods.

The country there is practically undeveloped. By the help of enterprise and capital, it will advance and prove itself to be, as it is, one of the richest countries in the world.

LINES OF PROGRESS IN THE EFFICIENCY OF THE COMBUSTION MOTOR.

By Edward C. Warren.

Many years ago that master mind in engineering work, the late Sir William Siemens, in the course of his investigations in heat motors, suggested the possibility of maintaining a continuous combustion in a closed chamber at constant pressure, using the whole of the expansive products of combustion for the production of motive power. The success of the four-cycle motor, however, and the diversion of his efforts to other lines of work, left this fertile field undeveloped, and it has remained for later engineers to take up the subject. The early death of Brayton interrupted his practical application of the principle, and until very recently nothing more has been done. Mr. Warren reviews the later efforts of engineers in this line of study, and accompanies it with some suggestions of his own which may lead to interesting practical results.—The Editors.

IN a paper read before the National Electric Light Association at its meeting in Chicago on May 28th, 1903, Prof. Elihu Thomson reviewed the development of the electric-station power plant from its beginning in 1878 down to the year just closed. He pointed out the various stages through which this class of equipment has passed—from the high-speed, belt-driven dynamo of the earlier days to the ponderous, slow-moving direct-connected generating equipment of the Corliss engine type, and more recently the reversal to an extremely high-speed type of electric machine, coupled direct to turbine engines—an outfit representing a radical departure in the matter of dynamo design as extraordinary as the previous rapid development in the direction of slow speeds and heroic dimensions. Prof. Thomson appears to conclude that, as compared to the older types of generating equipment, the steam "turbo-generator" possesses such marked advantages as to insure its adoption to some extent, but proceeds to point out that the recent rapid development in this field of yet another type of prime mover—the gas or oil engine—gives early promise of successful competition with the established occupants of this important field of power development.

However, after making clear the acknowledged tremendous advantage of high thermal efficiency possessed by this type of engine (stated to be fully double that of the best steam-engine plants), and almost venturing the prediction that this is to be the motive power of the future, Prof. Thomson raises a most pertinent and timely question in the following words:—

> "But if the gas engine should ever become a general source of power, what becomes of our driving? Will it be brought again to belting, or some form of gearing-up for increase of speed, or will the heavy, direct-driven dynamo again be found coupled to gas engines, instead of reciprocating steam engines? It is not probable that large gas engines will be run much faster than steam engines of equal power, so that the queries just propounded will need to be answered by future engineering."

Prof. Thomson makes it clear in this connection that the turbine is necessarily restricted to the use of *steam* as its motive fluid, owing to the fact that its efficiency cannot be made satisfactory except when exhausting into a high vacuum—a condition which is manifestly impossible of fulfillment with a non-condensable gas.

Agreeing, as we must, with the conclusions of this learned authority, we are thus confronted with a most embarrassing alternative. It would seem that we must soon make final choice between two widely different systems or methods of heat conversion, each of which possesses a certain series of commanding merits, which, however, seem inseparably associated with equally prominent and distinguishing faults. The various short-comings in either case serve about equally to disqualify both systems for the fulfillment of the ideal conditions demanded for the important work of converting the heat energy of natural fuel into the desired form of mechanical power. On the one hand, we have the newly developed and highly perfected rotary types of prime mover, representing the ideal of mechanical simplicity and functional operation, but grievously handicapped by the inherent deficiencies of their necessary adjunct, the time-honored steam boiler. On the other hand, less intensely interesting from an aesthetic standpoint, but commanding in its sturdily practical capacity for returning a fair equivalent for the fuel consumed, we have the "rational heat motor"—the oil or gas engine—with a net thermal efficiency double that of the steam plant, but embodied in the most primitive form and presenting all of the characteristic and limiting mechanical features of the reciprocating steam engine.

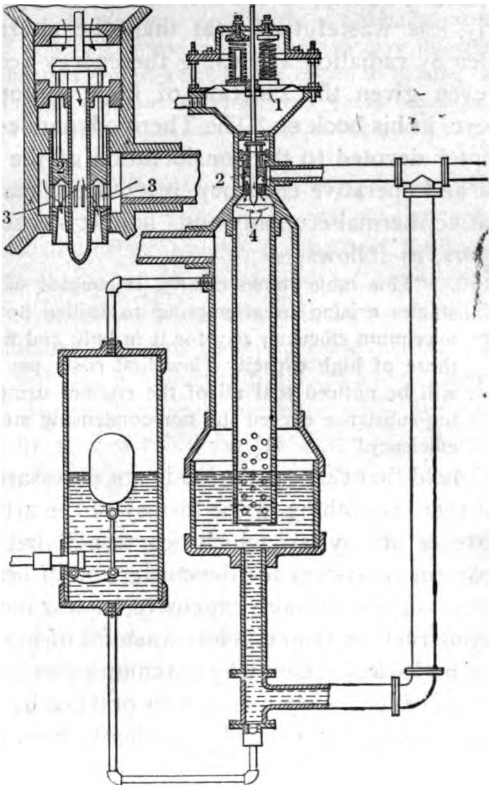
In all the history of the internal-combustion type of prime mover, dating back some two hundred years or more, little consideration appears to have been given to the purely mechanical features of design or to the perfecting of the internal-combustion engine as a machine. In fact, the reciprocating type of engine seems to have been invariably taken as the only available or possible mechanical arrangement of parts to perform the work of converting the heat energy of any expansible medium into work, and hence practically all recorded (or at present known), designs of engines or apparatus for the utilization of the direct expansive energy of liquid or powdered fuel, are based upon the mechanical cycle of the reciprocating piston. Nevertheless, some noteworthy attempts to vary this cycle of operations for facilitating the attainment of proper conditions of combustion, expansion, and the general conservatism of the heat energy evolved, have been recorded —notably, the "ready motor" developed by Brayton in 1872, in which every consideration of mechanical design and operative excellence seems to have been sacrificed to the attainment of a theoretical heat diagram, and, later, the "differential" gas engine of Atkinson, in 1885, in which the variant extremes of theory and application were well exemplified.

To the somewhat remarkable fact that the reciprocating piston has always been regarded as an essential factor in any method of direct energy conversion, is probably due the idea of primarily compressing the combustible element in order to facilitate combustion. Brayton used a separate reservoir, from which a compressed gaseous mixture was fed into the working cylinder, combustion proceeding slowly and at constant pressure. In the later commercialized gas and gasoline engine of the Otto type, the compression was carried further and made a part of the regular working cycle within the cylinder itself, this arrangement resulting in greater mechanical simplicity and somewhat superior thermal economy, due in large measure to the high pressures which could be employed and the higher piston speed made possible.

The development of modified forms for the use of the less volatile oils as fuel has been marked by the attainment of yet greater thermal economies and some improvement in mechanical design. The kerosene engine of Priestman explodes the vapor generated by atomizing and rarefying the oil prior to admission to the engine cylinder. In the Hornsby-Akroyd type, the fuel is injected as a liquid, vaporized by the heated contents of the cylinder, and exploded by the heat of compression alone, while in the well-known petroleum motor perfected by Herr Rudolph Diesel, we have the compression theory developed to its logical conclusion, and probably the nearest possible approximation to the conditions required by the ideal Carnot cycle.

Prof. Reeve, in 1897, proposed an apparatus for burning liquid fuel continuously, in connection with a water compartment through which the gases of combustion were passed in order to reduce those gases to a condition suitable for use in a steam-engine cylinder. The practical importance of this question of control of temperatures cannot be over estimated; it is of no value to secure perfect combustion and ideal theoretical cycles, if the temperature of the working medium be so high and the quality of the gases such as to burn out or corrode any available materials of construction.

In the apparatus patented by Bruno V. Nordberg in 1895, this idea is also given consideration, but, as in all similar systems recorded, the difficulties attendant upon the proper proportioning of oil and air under varying engine loads, and other like practical problems, seem to have defeated the commercial application of the idea.



CONSTANT PRESSURE GENERATOR OF PROF. SIDNEY A. REEVE.

The diaphragm 1 actuates the regulating valve 2, shown on enlarged scale on the left. The gas enters at 3, in the centre, and the air around it, the ignition taking place at 4. The float in the auxiliary chamber keeps the water at a constant level.

If the relatively excellent thermal efficiency of the petroleum motor were secured in a mechanical construction comparable with even the standard types of reciprocating steam engine in the essential points of uniform rotative effort upon the driven shaft, cost of construction, weight, bulk, durability, and general operative desirability as a mechanism, it would not be difficult to forecast the immediate future of power generation. The unfortunate fact is however well-known, that engines of this class invariably present mechanical disabilities which go far toward offsetting the practical value of their higher thermal efficiency. This fact has been observed so uniformly that it has come to be almost an accepted conclusion that improved thermal economy can be secured only by a corresponding sacrifice in the direction of mechanical availability in the motor. The mechanical shortcomings of the gas or oil engine seem to be accepted as probably inevitable, in view of the fact that these types employ a method inherently less wasteful of heat than the alternative method of boiling water by radiation and using the energy second-hand. This thought is even given the sanction of high authority by Prof. Sydney A. Reeve, in his book on "The Thermodynamics of Heat Engines." In a chapter devoted to the consideration of the practical features of first cost and operative efficiency, reference is made to a table showing the relative thermal economy and "builder's cost" of various types of heat motors, as follows:—

> "This table shows clearly, if coupled with the statements of the obstacles arising in attempting to utilize hot air, how those engines of maximum efficiency pay for it in bulk and first cost, and, vice versa, how those of high capacity (low first cost) pay for it in poor efficiency. It will be noticed that all of the engines using permanent gases for working-substance exceed the non-condensing steam engine in cost as well as efficiency."

I hold that this conclusion is not necessarily reasonable or true, and that there is nothing in the history of the art sufficiently indicating the existence of any law which determines that an economical engine, or apparatus or system for the conversion of heat energy into work, must of necessity be of more expensive, or less mechanically rational design or construction, than one less wasteful of heat. There appears, in fact, to be no logical reason why maximum thermal efficiency and maximum mechanical efficiency may not in practice be combined in a mechanical construction of reasonable simplicity, cost, compactness, and weight. The trouble, as previously indicated, appears to be that the modern internal-combustion engine has been built solely upon the primitive reciprocating-piston engine as a foundation, and in the effort to adapt this type of machine to a service which it was not originally designed to perform, the inevitable compromises have been made, all of which have tended to impair, rather than to improve, the essentially unsuitable mechanical design of this type of prime mover.

In this connection, the following from the concluding paragraph of an admirable paper read by Prof. Charles E. Lucke before the American Society of Mechanical Engineers in December, 1901, is of particular interest:—

> "There is one point, however, that should receive notice, that is, should we operate Brayton cycles with intermittent or continuous combustion? With intermittent combustion, the fire burns within the cylinder, and as nothing but fuel and air pass the inlet valves, they can be the more easily kept cool; while, on the other hand, the placing of the burner beyond the valve presents two undesirable features: first, the clearance must be unusually large; and second, the intermittent feed and

> cut-off of air and fuel at just the right time, without alteration of proportion in a fraction of a second, introduces a condition very difficult to meet. Continuous combustion within a fire-box is easier to handle, there being no alterations of feed, and the clearance may be as small as we please, whereas we have as undesirable the feeding of hot gases past the inlet valves."

In the present state of development of the internal-combustion engine, it is undoubtedly true that the gain in thermal efficiency over the steam engine is practically offset by the mechanical limitations and disadvantages which it presents. In the absence of any complete solution of the problem, it remains to choose between the two available, but about equally unsatisfactory, systems of energy conversion. The choice is truly a hard one, but this is a sternly practical age. The cost of fuel must continually rise, and though we may with reluctance admit it, the final choice must inevitably fall to that type of prime mover capable of returning the largest percentage of the precious fuel in the form of useful work. Even now it is being freely predicted on all sides that the internal-combustion engine is to be the universal prime mover of the future. Yet, while we are compelled to recognize the winning advantage of high thermal efficiency possessed by this type of motor, we cannot but deprecate the unfortunate fact that the general adoption of this type seems to mean inevitably a return to the slow-speed, cumbrous, costly, heavy-fly-wheel type of reciprocating engine, thus sacrificing the tremendous expenditure of energy and capital which has been, and is now being, made to bring the new rotary types of prime mover into the market, just at the time when all mechanical difficulties are being overcome and practicable machines of this type are being evolved, representing such a gratifying mechanical advance over the older unwieldy forms, the final passing of which, it has been hoped, we are about to witness.

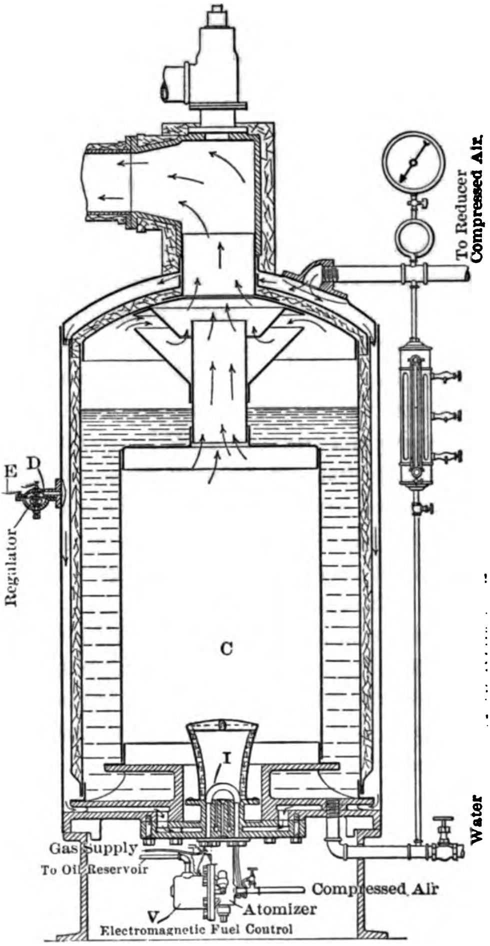
It may well be marvelled at that such an extraordinary and most unscientific state of affairs can exist in this age of enlightenment as to things mechanical, yet it is the logical result and a striking illustration of the independent development of single ideas which has characterized the trend of invention and improvement in this most important branch of scientific achievement. In the development of the steam turbine, the one idea has been to obviate the notorious short-comings of the reciprocating engine as a machine, with the result that a type has been evolved which, while representing the last degree of refinement in mechanical design and operation, yet shares with the older type its complete dependence upon that most primitive and inefficient method of heat conversion, the steam-boiler system. On the other hand, we find the gas or oil engine developed in accordance with the single idea of thermal efficiency, and dependent for its very cycle upon the inherent characteristics of the reciprocating engine, the basic design of which is generally conceded to be wholly and hopelessly unsuited to meet the growing demands of modern power application. And now we find these two widely different systems or methods of doing the same thing in active competition, though it seems to be the general impression in engineering circles that if one system is to be perpetuated, the other must of necessity be abandoned.

In one notable instance, a single representative manufacturing concern is at present engaged in marketing no less than three distinct types of electric generating unit in equal powers. The commercial argument that the special conditions of each installation determine whether the standard Corliss-engine type, the steam turbo-generator, or the multiple-cylinder gas-engine outfit is required for best results, can hardly be accepted as warranting the existence of a multiplicity of radically different systems of power development. The fact is that all of the present available systems are about equally deficient as compared with a standard of absolute excellence, each type of equipment excelling in certain particulars and presenting corresponding offsetting deficiencies; and while under such circumstances it is natural that any given set of conditions might be more nearly met by one type than by another, this fact cannot be accepted as an argument in favor of a number of imperfect systems as against a single system embodying all the virtues and only such defects as may be common to all existing types of equipment. It is toward the realization of such a universal system as this that our efforts should be directed, since only in this way can maximum economy and availability in manufacture and application be attained. It is with this ideal in view that the following suggestion is made as to a means of consolidating the known merits of the various existing systems into one rational universally applicable system of power development, thus making possible the high thermal efficiency of the internal-combustion engine in connection with the mechanically ideal rotary types of prime mover.

The general object of the apparatus shown is to create from liquid fuel a constant gaseous pressure suitable for the operation of a steam engine of the rotary type, and in doing this, to eliminate to the greatest possible extent the characteristic and unavoidable losses of both the steam boiler and the ordinary gas or oil engine.

In the sectional drawings is shown the proposed construction of such an apparatus.

Kerosene oil is used for fuel, being injected into the combustion chamber and atomized by means of a compressed-air supply maintained by a continuously operating pump at a pressure about 20 pounds above the proposed working pressure of the apparatus. The oil is injected under the surplus pressure of 20 pounds through the magnetically actuated control valve shown, and is atomized by the action of the air jets on its way to the combustion chamber C, ignition being accomplished by the internally-fired porcelain tube, I.



PRESSURE GENERATOR DESIGNED BY MR. E. C. WARREN.

As shown, the combustion chamber is surrounded by a water chamber, with which it is in free communication *via* the baffle-plate arrangement at the top. As heat is evolved by the combustion of the fuel in the interior chamber, a portion is radiated through the dividing wall into the water chamber and steam is formed, just as in a steam boiler, the essential difference being that the gases of combustion are confined within the boiler shell, allowed to mingle with the steam formed, and the mixture supplied to the engine as the motive fluid. It seems probable that the mixture so formed may contain about 25 per cent. of steam, highly superheated by contact with the gases of combustion, the gases, at the same time, being reduced to a temperature suitable for use in an engine of the type contemplated. This arrangement relieves the walls of the combustion chamber from all pressure strains and establishes ordinary steam-boiler conditions in the surrounding water chamber, so that the question of control of temperatures and pressures is brought within the limits of every-day steam-boiler practice.

The outer shell serves to form an air jacket around the water chamber, through which the surplus air from the air system is passed *via* a reducing valve, to gather up any heat radiating through the boiler insulation and return it to the combustion chamber to facilitate combustion. This heated air passes up around the burning mixture through the circle of small holes surrounding the atomizing tube, and forms an envelope of pure air which separates the combustible elements from the surrounding burnt gases, preventing objectionable diffusion and aiding in the attaining of perfect combustion.

In order to insure a perfectly combustible mixture it is of course necessary that the relative proportions of oil and air be accurately determined and maintained. This is accomplished by initially regulating or adjusting the air jets to give the proper flow of air relative to the oil supply, the latter being at a fixed rate, determined by the area of the discharge orifice.

The atomized mixture so obtained may or may not be in chemically perfect proportion for complete combustion. The velocity of efflux of the issuing jet of combustible is under control by means of the air valves in the atomizer and, if necessary, mechanical diffusion within the cone may be used to insure localization of combustion. With constant feed and velocity conditions, however, the envelope of pure heated air should insure the desired localization and perfect combustion.

Regulation of pressure is secured by wholly interrupting, intermittently, the flow of oil, by means of the magnetically actuated valve V, the pressure diaphragm D operating to interrupt the electrical circuit E on a rise of the working pressure, thus allowing a spring to close the oil valve; conversely, upon a fall of pressure, the circuit will be closed and the valve magnetically opened. This arrangement insures against any variation in the composition of the mixture, which might produce imperfect combustion, and only sufficient oil is admitted to maintain the working pressure and to meet the requirements of the engine load. This feature takes care of the question of feed variation, which, with any conceivable arrangement for throttling or graduating the supply, presents one of the most serious practical difficulties to be encountered in this class of apparatus. As a safety feature, provision is made whereby, in case of breakage or burning out of the ignition tube, the control circuit is broken, the oil valve closed, and the igniter flame extinguished.

The water level in the steam compartment may be maintained automatically in the case of small machines by means of the compressed-air system, or, in large powers, water may be injected after the usual manner of feeding steam boilers.

It would seem feasible to operate the apparatus with high economy at any desired pressure, since combustion will be equally perfect under all conditions of pressure or load.

As to the net thermal efficiency attainable, it is suggested that since all losses of the apparatus are reduced to merely a negligible amount of radiation, an economy considerably better than that credited to the best oil or gas engines may be reached by working the generator in connection with a turbine or rotary engine of high mechanical efficiency. In fact, it would appear that, with an engine having a mechanical efficiency of 90 per cent., and charging off 35 per cent. for exhaust, radiation, and leakage losses in the engine, and 10 per cent. for radiation and incidental losses in the "pressure generator," a net efficiency of heat conversion of something like 45 per cent. may be realized, and this in a combination giving the compactness, safety, and automatic features of the oil engine, together with the perfect mechanical operation and general reliability of the steam engine.

It is suggested that such an outfit fulfills in an unusual degree the requirements of power development in isolated plants, being self-contained and more compact than the slower-speed oil engine, yet there seems no reason to anticipate any limitation as to capacity when large powers are contemplated. An automatic equipment of this sort would also appear to be peculiarly adapted to solve the power problem in certain special fields for which there seems to be at present no suitable motive power—as, for instance, in traction service, the independently operated street car, the automobile business wagon, and the baggage-car electric lighting system for railway trains. The very material reduction of weight in marine-propulsion equipment would be obviously of great advantage in increasing the speed of steamships, while the improved economy of fuel may greatly extend the steaming radius and carrying capacity of vessels. In fact, it would seem that such a system—universally applicable and promising such gratifying economy in fuel, first cost, weight, bulk, and attendance—is most urgently required to keep pace with the rapidly growing demands of modern scientific and manufacturing progress, and must sooner or later prove the means of elevating the backward science of energy conversion to a plane commensurate with its tremendous importance as a factor in the development of the earth's natural resources.

THE PENALTY CLAUSE IN ENGINEERING CONTRACTS.

By W. Valentine Ball.

The ruling of the courts in the matter of penalty in engineering contracts is based on the common law which is the common heritage of English and American jurisprudence. Mr. Ball's examples therefore are properly drawn from cases on both sides of the Atlantic and have international interest and application.—The Editors.

NEARLY every contract which is entered into for the construction of machinery, the building of a ship, or other similar works, contains a clause specifying the time within which the work is to be completed. As the damages which may result from the non-observance of this clause are difficult to estimate, the written document usually provides a penalty which is to be paid by the contractor or manufacturer if he fails to carry out his obligation; but inasmuch as hardship may result from a very strict enforcement of the time limit, the time lost owing to any cause which is or may reasonably be in the contemplation of the parties when the contract is signed, is usually excluded, and no penalty is exacted in respect of time so lost.

It is obvious, however, that there are many causes of delay in the execution of a contract which cannot possibly be foreseen or allowed for by the employer or the contractor at the date of the agreement. Extra work may have to be undertaken either at the request of the employer, or on account of some delay or difficulty which could not possibly have been taken into account by the manufacturer when the tender was made. In these circumstances it is obvious that some system has to be adopted by which the question whether the contractor is to be held liable for delay can be decided. All questions could, of course, be settled by proceedings at law or by arbitration, but the vicissitudes of business require that minor questions which continually arise shall be decided with the minimum of delay and expense.

It thus comes about that the enforcement of what is known as the penalty clause is left to the engineer. His position, which will be further dealt with later on, is practically that of an arbitrator between the person who employs him, whom it will be convenient to refer to as "the employer," and the manufacturer or contractor who has undertaken the work in question. It frequently rests with him to say whether and under what conditions an extension of time for the completion of the work is to be allowed. In the exercise of his discretion he has only one duty, which is to act fairly and honestly; and so long as he does this, he is under no liability to anyone in so far as he is acting in a *quasi*-judicial position or as arbitrator.

In treating of the penalty clause and the interpretation which has been put upon it by the courts, it is necessary to refer to several cases which relate, not to engineers and contractors, but to architects and builders. For our present purpose, however, it is sufficient to say that the law which applies to architects, applies with equal force to engineers, and the principles upon which the penalty clause in a building contract has been interpreted, can be adopted in the case of a contract for the erection of machinery, for the building of a ship, or for the construction of a harbour or other works.

Before dealing with the question of extending the time it may be well to consider one or two cases in which penalties have been held to be recoverable. Thus, in some circumstances, penalties may be exacted although the delay is caused by alterations required by the employer. In the case of *Jones v. St. John's College, Oxford* (L. R. 6 Q. B. 115), it was agreed by a building contract that the plaintiff should before a certain date completely finish, according to certain specifications, a farmhouse and buildings, but subject to extras, alterations, or additions which might be made as mentioned in the agreement; and that the time mentioned in the agreements should be of the essence of the contract, so that if the work was not done by the day named, penalties might be deducted by the defendants from the amount owing from them to the plaintiff. Alterations were ordered, and the plaintiff failed to carry out the works within the time specified. The defendants having accordingly deducted penalties, the plaintiffs brought an action to recover on their contract. It was decided that they had undertaken to execute, not only the works specified, but also all alterations within the time prescribed in the contract, and that it was no implied condition of the contract that the alterations should be such as could reasonably be completed within this time. Where, however, in the case of alterations being ordered, the engineer has power to extend the time, but has not exercised it, and there is delay, the builder or manufacturer must not be mulcted in penalties.

In the case of *Westwood v. The Secretary of State for India,* ((1863) 7 L. T. 736), the plaintiff contracted to build a ship. The time of completion was fixed. The contract provided that alterations might be ordered, and that the engineer was to have power to allow an extension of time for them. Failure to complete within the fixed or extended time was to subject the plaintiff to certain penalties. The engineer ordered various alterations, but the time for completion was not extended, with the result that the shipbuilder exceeded the time specified in the contract. In an action brought by the shipbuilder for the cost of the alterations, the Secretary of State entered a counterclaim for penalties. By way of answer to the counterclaim it was pleaded that the alterations ordered had made it impossible to complete the work within the specified time. The court held that this afforded a good answer to the claim for penalties.

It is a general principle which is consonant with justice that where delay is caused by the intervention of the employer, a waiver of the penalty clauses will be implied. Thus when the employer (as must often happen) during the progress of the work directs alterations to be carried out within a reasonable time, and these alterations are so mixed up with the work contracted for that it is impossible to separate them, a waiver of the penalty clause may take place.

In the case of *Thornhill v. Neats,* (8 C. B. N. S. 831) the plaintiff agreed to build six houses by a certain day and was placed under penalty if they were not completed. Before the date fixed for completion, it was agreed that the plaintiff should perform other work in and upon the houses, this additional work to be done within a reasonable time. In an action brought by the builder for work and labour done, the building owner set up, in answer, a claim for penalties for non-completion within the time specified. It was held however that there was a good legal answer to the claim for penalties on the ground that the defendant had in effect waived the penalty clause by agreeing that the entire work should be done within a reasonable time.

Again in *Russell v. Sa Da Bandeira* (13 C. B. N. S. 149) a clause respecting penalties, in a contract for the building of a ship, imposed a penalty of £5 a day on the shipbuilder for every day after a certain day if the ship should not be then delivered. The ship was not delivered until long after the day appointed, but a large portion of the delay arose from the interference of the building owner or his agent. It was decided that no sum in the nature of a penalty was recoverable by the employer.

Similarly, if the time of commencing the work is delayed, through no fault of the contractor, he will not be liable to pay penalties. Thus in the case of *Holme v. Guppy* ((1838) 3 M. & W. 387) the plaintiffs contracted to do for £1,700 the carpenters' work in a brewery which was being built for the defendants. The work was to be completed within four and a half months from the date of the contract, and in default of completing within the said four and a half months the plaintiffs were to forfeit £40 per week for each week during which the carpenters' work was delayed beyond the 31st day of August, 1863—the expiration of the four and a half months. The defendants did not give the plaintiffs possession till four weeks after the contract was made. The plaintiffs did not complete till five weeks after 31st August. The defendants claimed to set off five penalties of £40 against the last instalment of the contract price. It was decided by the court that they could not do so; that the undertaking to complete was put an end to by the defendants' default in not giving the plaintiffs possession at the proper time; and that there was no evidence of a new contract to complete at any other time than the 31st August.

In an American case (*Mansfield v. New York Central, etc., Ry. Company* (1886), 102 N. Y. 205), certain contractors agreed to erect an elevated railway on a foundation to be prepared by the employers. It was held that the proper preparation of the foundations was an indispensable condition precedent to performance, and if the employers made default the contractor was not only dispensed from exact performance but had the right either to rescind, or if he elected to continue the work, to recover damages for the expense to which he had been put by the delay and default of the employer.

Subject to what has been stated above, the contractor or manufacturer is liable to pay penalties for delay, even when that delay is occasioned by matters over which he has no control. Thus it was decided in the case of *Budgett v. Binnington & Co.*, ((1890) 25 Q. B. D. 320), that prevention due to causes other than the employer's intervention, such as a strike of workmen, is not an excuse for failure to complete within the proper time. This principle, and the frequency with which strikes have in the past prevented the due fulfilment of important engineering contracts, has given rise to the insertion of a strike clause in every contract of importance. It should be observed, however, that where there is such a clause, the strike may, nevertheless be of so prolonged continuance as so to alter the conditions of the contract and the arrangements of the parties to it as to amount to a determination of the contract.

As has been already stated, the points which arise from time to time during the progress of the work are frequently left to the decision of the engineer, and his opinion is binding upon either party. This principle is illustrated by several cases. Thus in an action on a builder's contract, which provided that all the works should be left complete and clear, to the satisfaction of the architect, and did not contain any provision for payment by instalments, it was decided (1) That the completion of the works to the satisfaction of the architect was a condition precedent to the builder's right to recover on the footing of the contract; (2) That he was not entitled to recover for the value of work done as to which, while incomplete, the architect had expressed approval so far as then partially executed, but which was not subsequently completed to the architect's satisfaction (*Richardson v. Mahon* 4 L. R., Ir. 486).

The necessary power and authority must, however, be conferred upon the engineer by the clearest possible language, for in agreeing to be bound by the decision of some one who is retained and paid by the employer, a contractor in one sense hands himself over to the enemy.

In the case of *Lawson v. Wallasey Local Board,* (11 Q. B. D. 229), the plaintiff entered into a contract with the defendants to remove 10,000 cubic yards of the Mersey contiguous to Leacombe Ferry for £5,000, and to finish the work completely under the direction and to the satisfaction of the defendants' engineer by the 1st of October 1878, subject to such an extension of time as the engineer might think reasonable, in case a temporary staging then erected on the site of the work should not be removed within such a time as would enable the plaintiff to complete the work by the 1st of October 1878. The defendants were to make monthly payments on the certificate of the engineer to the amount of 80 per cent. of the value of the work done during each month, and the balance of the sum of £5,000 on the completion of the work. There was also a clause in the contract providing that if any difference should arise between the local board and the contractor concerning the work contracted for, or concerning anything in connection with the contract, such difference should be referred to the engineer, and his decision should be final and binding on the local board and the contractor. The work was completed on the 11th November 1879, and then a correspondence took place between the plaintiff and the engineer with reference to the plaintiff's claim against the defendant board. The engineer admitted that the plaintiff was entitled to compensation for the expense caused by delay in consequence of the non-removal of the staging, and agreed to allow £15.10.0. per day for thirty-eight days, but they could not agree upon the amount due to the plaintiff for extra work and other expenses. In June 1880, the engineer sent a certificate to the Works Committee of the defendant board, stating that the work was finished to his satisfaction, and that £1,065.19.0. was due to the plaintiff, and the defendants sent a cheque to the value of £962.6.2., that being the balance of the sum certified after making certain deductions. The plaintiff, after giving credit for this sum, brought an action against the defendants for £2,489.13.11. It was decided that it was not a difference concerning a matter in connection with the contract, and as to which the decision of the engineer was conclusive. In order to bind a contractor to the certificate or decision of an architect or engineer appointed by the party for whom the work is done, there must be very conclusive language in the contract. It was decided, also, that the documents set out in the case did not amount to a contract by the engineer, or a reference to or award by him as to the plaintiff's claims.

While it is possible for the manufacturer or contractor to become bound by the decision of the engineer, it is not so easy for the employers to arrogate to themselves the right of practically deciding whether penalties shall be paid or no. This proposition may be well illustrated by reference to another building case, namely that of *Wells v. Army and Navy Co-operative Society* (86 L. T. 764). There it appeared that by a clause in a building contract the contractors were to complete the whole of the works within a certain time unless they were delayed by specified matters "or other causes beyond the contractors' control, satisfactory proof of all which must at the time of occurrence be at once afforded to the board of directors of the employers, who shall adjudicate thereon and make due allowance therefor if necessary, and their decision shall be final." It was decided that the exclusive jurisdiction of the directors under clause 16 did not extend to delay caused by undue interference by the building owners or their architect with the conduct of the works and by default in not giving possession of premises on which work was to be done, and in not providing plans and drawings in due time, and that the plaintiffs were, therefore, relieved from their liability for penalties under the contract for delay.

The power of granting an extension of time, which, as we have seen, is frequently conferred upon the engineer, must be exercised by him in strict accordance with the terms of the contract between the parties. This was emphasised in the very recent case of the *British Thomson Houston Co. (Ltd.) v. West Brothers,* (1903) (19 T. L. R. 493). There an action was brought by building owners to recover penalties for non-completion on the date agreed under the contract between the parties. This document provided that the architect might, in certain circumstances, extend the time for the completion of the work, but did not expressly confer upon him the power to deal with penalties. There was admittedly a delay in the execution of the works, but the defendants contended that the delay was impliedly permitted by the architect, who had given his final certificate in the following form:—"We hereby certify the sum of £536.15.5 is due to Messrs. West Brothers in settlement of contract for the erection of power stations." The question of law for the opinion of the Court was whether, in view of the certificate, and of the powers of the architect under the contract, this certificate afforded a complete answer to the plaintiff's claim. Mr. Justice Phillimore, in giving judgment, said that the following, which is taken from *Hudson on Building Contracts,* was an accurate statement of the law:—"If the architect gives a final certificate without allowing any deduction for penalties, it will be presumed that he has extended the time for completion, unless, as in the foregoing illustration, it is proved or admitted that the matter has not been determined by him, or was not expressly or impliedly within his jurisdiction." His lordship went on to say that the architect's certificate at most raised a very strong presumption that in giving his certificate he had taken all the circumstances of the case into consideration. That presumption, however, might be rebutted, and in all the circumstances he would have to enter judgment for the defendants.

Hitherto we have dealt entirely with the penalty clause; there is another clause of a similar nature which is often inserted in these contracts, the administration of which depends very largely upon the engineer.

We refer to the "bonus" clause. A contract sometimes contains a clause providing that a bonus shall be paid to the contractor for expedition. If there is such a clause, and the engineer has power to extent the time, this power, according to a New Zealand case, is not to be exercised by the engineer for the purpose of enabling the contractor to earn the bonus, but, on the contrary, to save him from the penalties. In the case in question *(Ware v. Lyttelton Harbour Board* (1882) 1 New Zealand L. R., S. C. 191), it was agreed by a contract that "The Board will grant the contractors a bonus of £100 per week for every week or part of a week in which the contract shall be finished within the specified time." The contract was to complete certain specified works and additional or extra works if properly ordered. The date for completion was the 7th April, 1882. The plaintiffs completed six weeks before the appointed day and received £600 bonus. They claimed further bonus for time taken as they alleged by extra works. The engineer had power to extend the time. It was decided that the clause only applied in case the engineer should consider that the contractors could not complete within the time, to save the contractors from penalties, and not to give them additional bonuses.

If the employer agrees to give a bonus for expedition, and the contractor to pay a penalty for delay, and the covenants are independent, and the covenant to pay a penalty for delay is absolute, if the contractor has been prevented by the employer from completing by the date fixed, he must pay or allow further penalty; but he has an action for damages against the employer, including the deductions caused by the employer's neglect.

"Any other construction," said Baron Alderson in *Macintosh v. Midland Counties Railway Company,* ((1845) 14 M. & W. 548), "would lead to this conclusion, which we think an unreasonable one, that the non-supply of a single rail or chair (by the Company) at the time specified for its delivery, although in the result wholly immaterial to the facilities for completion, would entitle the plaintiff to receive the £15,000 given as expedition money, without his giving expedition for it."

The question has frequently arisen whether in acting in his professional capacity an engineer can be sued for negligence either by the building owner or by the builder whose work he has to criticise. It is not necessary for our present purposes to go at length into the question; it is sufficient to point out that so far as he acts as an arbitrator the architect cannot be held responsible.

In *Restell v. Nye* (17 T. L. R. 304), the facts were that by a building contract the certificate of the architect, employed by the building owner, showing the final balance due or payable to the contractor, was to be conclusive evidence of the works having been duly completed, and that the contractor was entitled to receive payment of the final balance. It was decided in the Court of Appeal, that the architect, in giving his final certificate, was placed in the position of an arbitrator as between the building owner and the contractor, and was not liable for negligence. An engineer would be in a similar position.

MECHANICAL AND COMMERCIAL ASPECTS OF THE ALCOHOL MOTOR.

By Henri Dupays.

Local conditions make the alcohol motor perhaps more immediately important on the Continent than elsewhere, but every extension of the supply of industrial fuel is significant. Alcohol has, further, qualities which recommend it strongly for use in internal-combustion motors applied to the driving of automobiles, and it is in this relation that M. Dupays discusses it most fully. His intimate connection with the most notable experimental researches which have been made in this direction give him especial standing as an authority.—THE EDITORS.

ALCOHOL can be obtained from all substances containing sugar, or containing compounds which may be transformed into sugar. The sources of supply are therefore very numerous and large quantities are annually thrown upon the market. Equally numerous are the industrial uses to which it may be put, and during very recent years alcohol has taken an important place, especially among the available agents for the generation of motive power, of light, and of heat. This mode of utilisation of alcohol, however, is susceptible of much larger development, and that fact makes it important to review its adaptability to purposes of power generation and the bearing of its characteristic properties thereon.

Not until recently has alcohol for motor purposes been exploited to any great extent, other than as a substitute for water in the boiler, or as an admixture to the usual heat medium. The years 1894 and 1895 saw the first attempts, in Germany, to employ alcohol in internal-combustion engines, in place of the distillation products of petroleum. These attempts, it may be added, were not successful. In 1897, however, Max Ringelmann showed in a series of experiments conducted by him at the Experimental Mechanical Laboratory (*Station d'Essais de Machines*) at Paris, that with certain precautions, such a substitution was feasible. Since then, in 1899 and 1900, the new fuel has come into prominence in several automobile road races.

The results of these various investigations were not accepted without hesitation, however, and gave rise to much acrimonious discussion. At the same time the idea was slowly gaining ground, so that, when the unprecedented vintages of 1900 and 1901 threw an alcohol on the

ALCOHOL AUTOMOBILES ON THE NORTHERN CIRCUIT TRIALS, 1902.
Taken during the stop in a neutral control.

market which could compete in price with that made from beets and from molasses in the north, and, by the depression of the value of wine, forced all large owners of the south to do their utmost to create a market for this product, it was not long before the subject was granted serious attention. In November 1901, and later, in May 1902, the Department of Agriculture (of France) offered special prizes for researches tending to widen the field of utility of alcohol. Under the influence of careful supervision and of scientific methods, these researches have borne many valuable results. In the succeeding pages I shall particularise briefly on some of the facts thus discovered, basing the observations upon the experiments of Max Ringelmann at the Experimental Mechanical Laboratory of Paris, experiments in which it has been the good fortune of the author to take part.

Two kinds of alcohol are applicable to motor use:

1.—Denaturalised alcohol, which consists of pure ethyl alcohol to which is added, in France, per hectolitre, 10 liters methyl alcohol, containing 20 per cent. acetone, and 0.50 grams heavy benzine.

The main object of this denaturalizer is to protect the excise revenue against frauds; it serves its purpose rather indifferently, however, being not only quite expensive (francs 10.90 per hectolitre) but also quite unreliable, as it may easily be removed. It also diminishes the calorific power.

2.—Carburetted alcohol, which is denaturalised alcohol to which a hydrocarbon has been added in varying proportions, the substance most generally used being benzine. The object is to increase the calorific power of the fuel. A 50 per cent. mixture seems to give the best results.

The chemical composition, of course, is by no means constant, each class being simply a mechanical mixture. Sorel has determined the following values for pure denaturalised alcohol, and for a 50 per cent. carburetted alcohol, using a kilogramme for the determination:—

	Carbon.	Hydrogen.	Oxygen.	Water.
Denaturalised Alcohol...............	0.437	0.111	0.303	0.141
Carburetted Alcohol..................	0.690	0.095	0.147	0.068

An objection frequently raised to all alcohol for fuel purposes is its low calorific power. The following table, which gives the value of this constant for the different liquids at present used in internal-combustion motors as determined on Mahler's calorimeter, will show that this claim is not unfounded:—

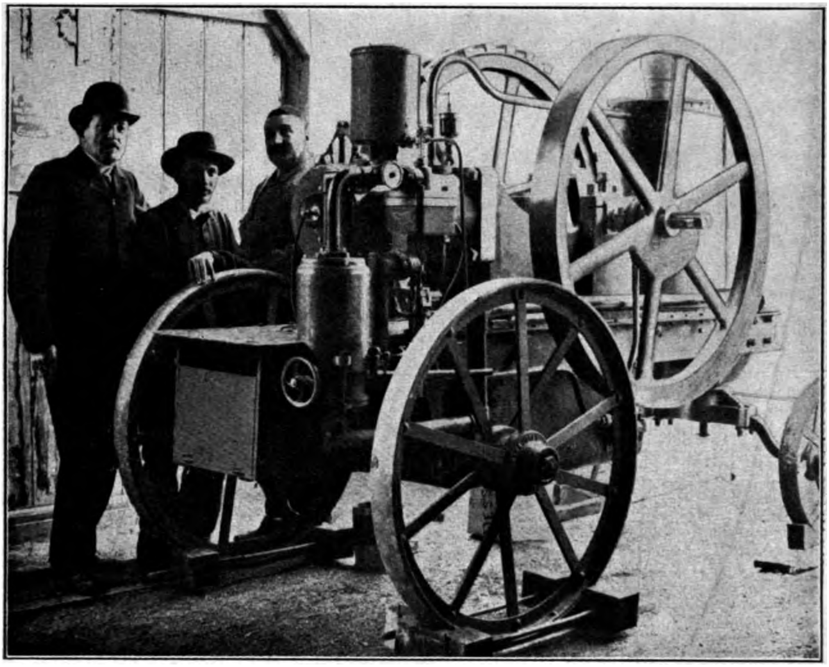
Substance.	Calorific Power.	
Denaturalised Alcohol..........	5,906 calories per kg.	(10,631 BTU per lb.)
50 Per Cent. Carburetted Alcohol	7,878 " " "	(14,180 " " ")
Light Petroleum Essence (Mean)	10,500 " " "	(18,900 " " ")
American Crude Oil...........	10,913 " " "	(19,643 " " ")
American Refined Petroleum...	11,047 " " "	(19,884 " " ")

These figures certainly do not look favourable for alcohol.

On the other hand, we must remember that owing to the lower heat generated by the combustion of alcohol, a motor using that fuel will run more smoothly than if one of the other substances had been employed. Further, a kilogramme of alcohol requires less air for complete combustion than does a kilogramme of mineral oil (according to Ringelmann (1894) 1.4, and according to Sorel 1.3 to 1.5 the theoretical amount). This decreases the heat losses in the exhaust gases very materially, and gives a higher thermal efficiency.

One of the advantages of the alcohol motor is that, when properly regulated, the escaping gases do not have the disagreeable odour which is so objectionable with gasoline machines. In fact, except for a short time after starting the machine, when a little formic aldehyde is given off, there is practically no smell of any kind.

Starting a motor which burns carburetted alcohol is no more difficult than starting one that derives its energy from the lighter derivatives of petroleum, and is done in the same way in both cases. Denaturalised alcohol, on the other hand, will not vaporise sufficiently for good service at temperatures below 20 deg. C., so that it will be necessary either first to heat up the carburetter slightly by burning a little of the liquid under it, or to let gasoline or a similar substance take the place of the alcohol during the first few explosions. After a very short time the heat of the exhaust gases, if properly utilised, will be sufficient to keep the carburetter at the required temperature, and to neutralise the cooling due to evaporation.



AN ALCOHOL-MOTOR PORTABLE ENGINE.

Alcohol does not, as too often alleged, foul the admission valves and the sparker. Cases are known, it is true, where a slight deposit of lamp-black and even of tar has been formed; but as such occurrences are very rare, we should not blame them to the fuel used, but rather to a bad carburetter.

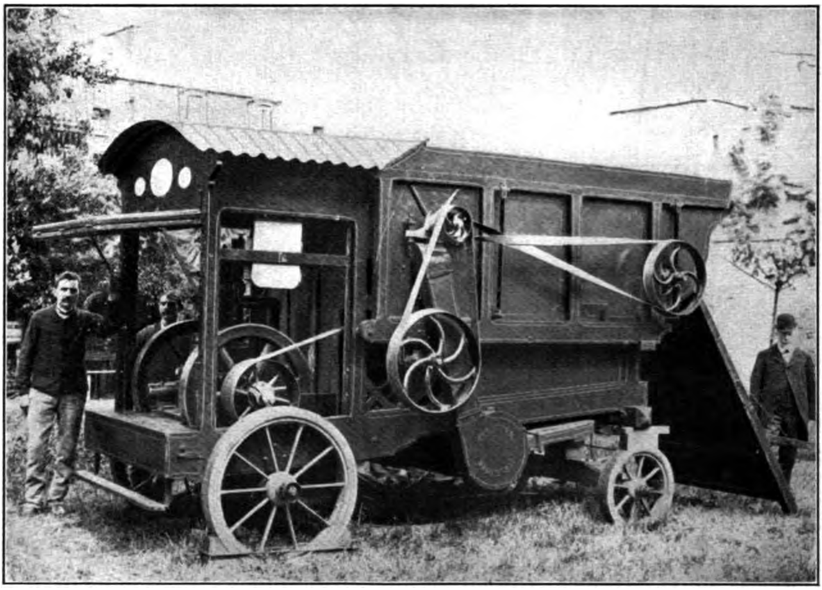
The water of condensation from the exhaust always contains a little acetic acid, the proportion being very variable. The amount is rarely sufficient to attack the valves, however, and with a little care trouble from this source may always be avoided, for it is found that corrosion does not take place unless the motor is allowed to cool and the condensed water to remain in contact with the metal for some time. Greas-

FOUR-CYLINDER 50-HORSE-POWER ALCOHOL MOTOR IN OPERATION.

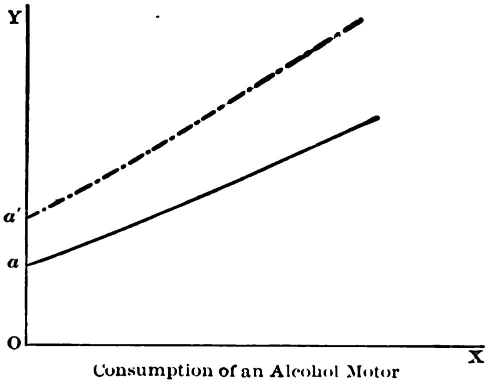
ing the cylinder slightly when not in use will therefore be a perfect safeguard.

As with all internal-combustion motors, the most important member is the carburetter. Improper construction in this detail will always react very unfavourably on the performance. Unless the correct proportion between the air and the gas be maintained, the combustion will not be complete. This is especially true if not enough air is admitted, the result being a deplorable loss of efficiency. Some motors lose in this way 50 and even 80 per cent. of the available energy of the fuel. Aside from the loss in efficiency caused thereby, incomplete combustion is further objectionable in that it sets up secondary chemical reactions, aldehyde and acetic acid, methane and its derivatives, acetylene, benzine, and even formol and hydrogen being produced in some cases. On this point the chemical researches of Sorel at a laboratory set aside for this purpose at the *Station d'Essais de Machines* have led to some very interesting conclusions; conclusions, it may be mentioned, which are fully borne out by the results of purely mechanical investigations. Referring in particular to a very common method of charging the air with vapour, Sorel says that "it is very bad practice to pass more or less highly heated air either over or through a liquid consisting of several substances in a state of purely mechanical mixture, the surface of the liquid being held at a constant level by means of a float, so as always to be in excess. The direct and unavoidable result of this process will always be constant change in the composition of the liquid, and under such conditions no motor can act satisfactorily." A similar line of reasoning applies to carburetters where "the air is charged with inflammable gases by being brought in contact with wicks dipping into the liquid mixture to be utilised." The best carburetter from a mechanical point of view will be the one which introduces automatically into each cylinder that quantity of alcohol—which may be constant or variable, depending on the system of governing employed—which is strictly necessary to do the work, and in which the temperature is such as to insure rapid and complete evaporation of this charge in the least volume of air required to produce complete combustion. Carburetters fulfilling these conditions for alcohol exist. Constructed originally to be used in connection with shale oil, they have acted perfectly when alcohol, either pure or carburetted, was substituted. It might be difficult to show that the vaporisers now used with light mineral oils give equal satisfaction.

Max Ringelmann is responsible for the very elegant method of expressing the fuel consumption of an internal-combustion motor which



THRESHING MACHINE OPERATED BY AN ALCOHOL MOTOR, AT THE MECHANICAL TESTING LABORATORIES.



Consumption of an Alcohol Motor
——— 50 per cent carburetted alcohol
·—·— Pure denaturalized alcohol
X. Brake horse-power
Y. Consumption in kilogrammes per hour

we give below. The hourly consumption y is a linear function of the power developed, x, and is expressed by the formula

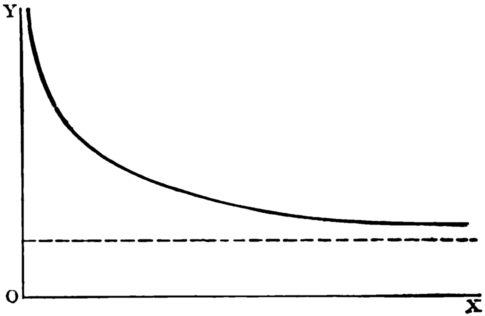
$$y=a+bx.$$

This is the equation of a straight line whose intercept on the axis of y, a, is the consumption when the machine is running under no load. The value of a will depend on the construction, the adjustment, the sparking mechanism, the method of governing employed, the heat losses, and on other similar details. The constant b is independent of the machine; it varies inversely as the calorific power of the fuel used. Thus b will be greater for denaturalised alcohol than for 50 per cent. carburetted alcohol, and greater in the ratio of 10 to 7. Again, the hourly consumption of a given motor when using pure denaturalised alcohol, and when using 50 per cent. carburetted alcohol, will be as 10 is to 7, that being the inverse ratio of the calorific powers of the two fuels.

The specific consumption Y, that is, the consumption per unit of power, is given by the formula

$$Y = \frac{y}{x} = \frac{a}{x} + b$$

which is the equation of an equilateral hyperbola with asymptotes $x=o$, $y=b$. The specific consumption therefore diminishes as the horse power increases. It is always less in stationary than in portable and automobile engines, the former having neither ventilating devices nor circulating pumps for water cooling. The following table shows the specific consumption of the best constructed motors entered in the international exhibit of 1902 as deduced from in-



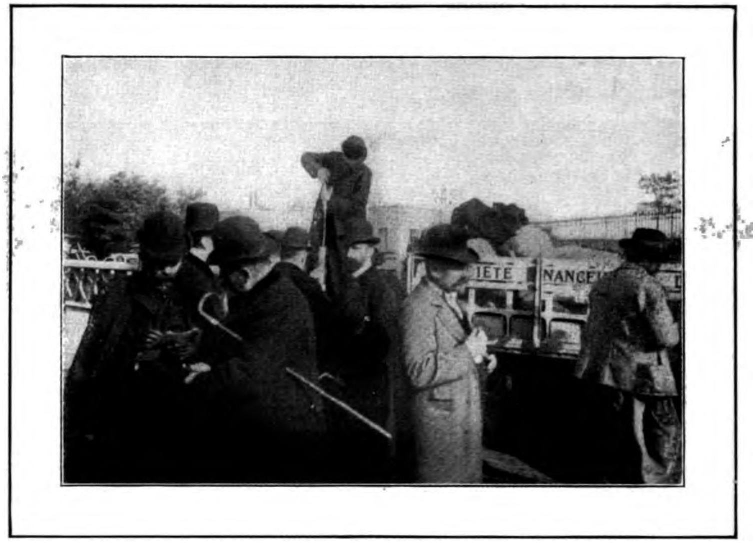
Relative Consumption of Alcohol Motors
X. Brake horse-power
Y. Consumption per horse-power hour

vestigations carried on at the Experimental Mechanical Laboratories. The figures are in the metric system; their English equivalents are added in brackets.

EXPOSITION OF ALCOHOL MACHINES, 1902. MOTOR SECTION.
In the centre is the automobile track.

Motor.	Maximum Horse-Power x.	Consumption per H. P. Hour Y for 50 Per Cent. Carburetted Alcohol.
	Low Speed Stationary Motors.	
Brouhot	1.83 (1.80)	0.551 kg. (1.231 lbs.)
Sté. de Winterthür	5.15 (5.08)	0.326 kg. (0.729 lbs.)
Pruvost	8.35 (8.24)	0.337 kg. (0.753 lbs.)
Brouhot	16.34 (16.12)	0.233 kg. (0.521 lbs.)
Sté. de Winterthür	34.37 (33.90)	0.293 kg. (0.655 lbs.)
	Vehicle Motors.	
Beaupré	6.39 (6.30)	0.459 kg. (1.026 lbs.)
Brouhot	8.31 (8.20)	0.412 kg. (0.921 lbs.)
	High Speed Motors.	
Sté. l'Aster	6.14 (6.05)	0.387 kg. (0.865 lbs.)
Panhard et Levassor	8.84 (8.72)	0.377 kg. (0.843 lbs.)

One of the large prospective consumers of alcohol will be the automobilist. In the northern circuit a machine burning carburetted alcohol attained a mean speed of 72 kilometres (44.7 miles) per hour on a



ALCOHOL MOTOR TRUCKS ON THE ROAD, PARC D'ACHÈRES, 1901.

Taking a sample of alcohol from the reservoir.

poor road and long run of 924 kilometres. A Panhard or Levassor motor using the same fuel made an average of 90 kilometres (55.9 miles) per hour on the first stage of the Paris-Vienna race. Such a high speed had never before been reached on the Paris-Belfort run. The adaptability of alcohol to this use cannot be doubted, therefore; to make it a commercial success, however, it would be necessary to establish bases of supply throughout France where the tourist could replenish the reservoirs of his car. Unfortunately it must be acknowledged that so far very little has been done in this direction.

The competitive exhibition of 1902 necessitated the installation at the Experimental Mechanical Laboratory of a dynamometer constructed specially for measuring the effective power at the wheel rim of automobiles. The principle of this device is very simple. The car is mounted on two leather belts running lengthwise over pulleys. The resistance of these belts is regulated by means of a brake, and the car is held in place by being attached in the rear to a fixed point through a self-registering dynamometer. Experiments on the fuel consumption made in this way were found to agree perfectly with those made during road tests. The table on the following page shows a few of the figures obtained, the English equivalent of the metric figures being given in each case, in the parenthesis.

	Mean Speed per Hour.	Hourly Consumption of 50 Per Cent. Carburetted Alcohol.
On the Road............	21.0 km. (13.0 m.)	1.20 kg. (2.64 lbs.)
	18.5 km. (11.5 m.)	1.40 kg. (3.09 lbs.)
	17.5 km. (10.9 m.)	1.44 kg. (3.18 lbs.)
On the Apparatus.......	13.0 km. (8.1 m.)	1.486 kg. (3.28 lbs.)

To the buyer of a racing machine the available effective power at the wheel rim is the main point of interest. For touring cars, however, and even more so for delivery wagons and trucks, and for all vehicles used for business purposes, the consumption becomes an important factor. Researches made on the latter class of wagons only demonstrate that the fuel consumption per tonne per kilometre decreases as the total transported load increases; as indeed theory would lead us to expect.

H. P. of the motor (English in brackets.)	Weights in kg. (in lb.)		Mean velocity per hour in km. (in miles).	Consumption of 50 per cent. carb. alcohol in cu. cm. per tonne-km. (cu. in. per ton-mile).	
	Of the empty car.	Of the useful load.		Of the total load.	Of the useful load.
4.5	910	1186	15	38.7	99.6
(4.44)	(2006)	(2615)	(9.3)	(4.18)	(10.76)
10.0	1396	1614	21.9	27.3	134.2
(9.86)	(3078)	(3559)	(13.6)	(2.95)	(14.49)

The consumption per tonne-kilometre of the useful load is influenced to a certain extent by the weight of the wagon, so that economy demands that this latter be made as small as possible without exceeding the limits of safety imposed by the strength of the materials of construction.

From the foregoing it will be evident that from a purely technical point of view alcohol is well fitted to take the place of petroleum and its derivatives for driving stationary, vehicle, and marine motors. Unfortunately, however, the commercial aspects of the situation are not nearly so encouraging. In spite of the liberal encouragement given by the government, and in spite of the rapid strides made in perfecting the mechanical appliances, the industrial development of alcohol as a fuel is at present nearly at a standstill. And this rather distressing condition of affairs is due entirely to those whose own interests should prompt them to foster the growth of the industry; for at the present price of the commodity, alcohol cannot compete successfully with its rivals.

The duties imposed by the State upon the manufacture of alcohol have frequently been changed; at the present date a rebate of 9 francs per hectolitre is allowed on all alcohol which has undergone the process of denaturalisation, and the only taxes collected are one of 0.25 francs for registering the output and one of 0.80 francs for analysing. Under these conditions the cost of denaturalising a hectolitre of alcohol is francs 10.90 less the rebate (which for a hectolitre of denaturalised alcohol containing 81.5 litres of pure alcohol amounts to $\frac{9 \times 81.5}{100}$ = 7.3335 francs), that is to say,

francs 10.90—francs 7.335=francs 3.565.

This added to francs 45.25, the market price of the alcohol, gives

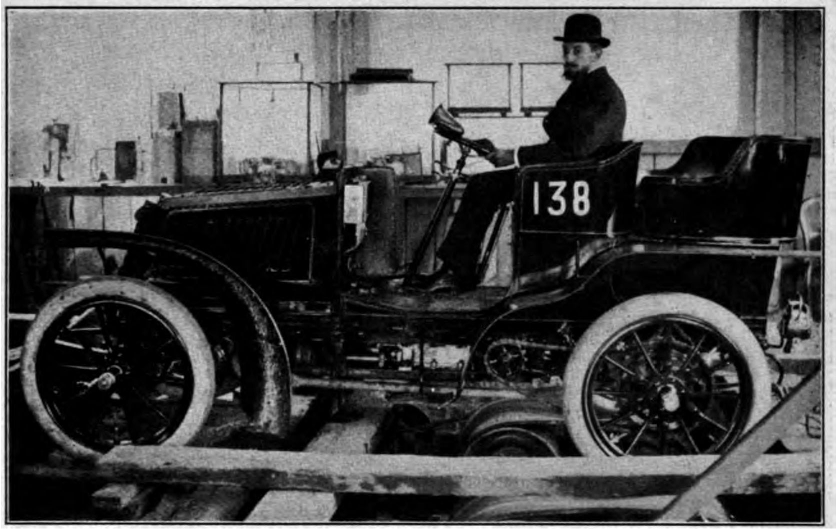
francs 45.25+francs 3.565=francs 48.815

as the cost of one hectolitre of the denaturalised product.

Now this figure is entirely too high. Speculation, and speculation alone, is responsible for it. Under normal conditions it should be perfectly possible to sell this article for from 25 to 30 francs per hectolitre. Herein, as far as we can see, we must recognise the one stumbling block which has prevented alcohol in France from taking that position among the available fuels of today to which its characteristic properties would seem to entitle it. Manufacturers have thought it to their interest to keep up the prices; the consumer, however, is by no means willing to second them in this effort.

Germany is very frequently quoted to us as an example in this matter. Denaturalised alcohol can be bought there for franc 0.25 per litre delivered at any railroad station. Several causes contribute to make this low price possible. One of them is the unusually low cost of production in that country, alcohol being there manufactured largely from potatoes, which require but little labour in their cultivation and can

ALCOHOL MOTOR OPERATING A PUMP.



ALCOHOL MOTOR CARRIAGE UNDER TEST AT THE "STATION D'ESSAI DE MACHINES."

be successfully grown in ground which is otherwise of very slight value. Another reason lies in the very stringent legislation against adulteration. But the most important cause is found in the application of the principle of co-operation. The syndicate of agricultural distillers, which controls 80 per cent. of the output, sells its entire product through a single agency—the *Centrale für Spiritus Verwerthung* (Office for the Sale of Alcohol) established in 1899. The commercial organisation of this company is in many ways remarkable; it has succeeded in assuring to the manufacturer a satisfactory profit, and to the public a condition which in France is still a thing to be hoped for in the future, namely, a low price for alcohol.

THE TRANSMISSION LINE.

THE FIRST HYDRO-ELECTRIC STATION OF GREECE.

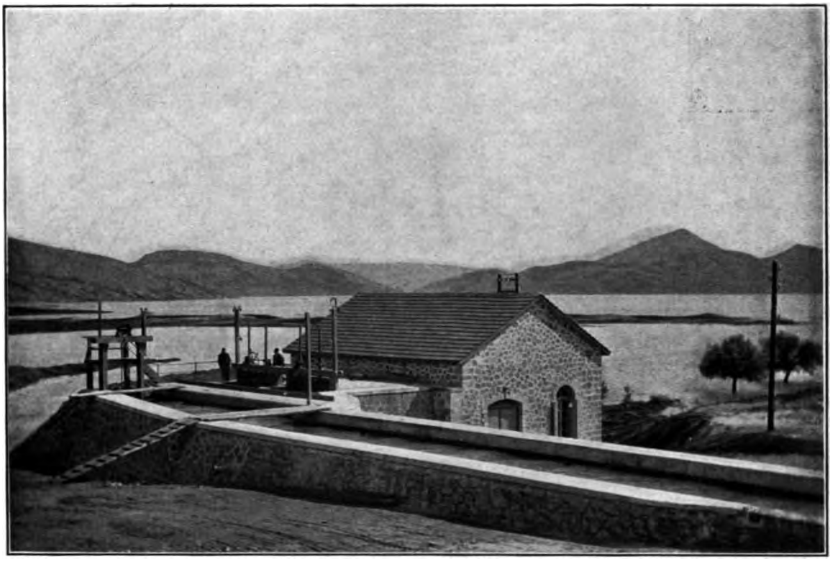
By Emile Guarini.

Apart from the interest suggested by M. Guarini, his article is highly suggestive of the keenness and promptness of Continental engineering manufacturers in finding new outlets for their products. In this aspect the short account may have some hints for the engineering trades nearer home.—The Editors.

GREECE, it is well-known, is generally rocky, sterile, and poor in water resources. Pindar and the other poets of ancient Greece do indeed sing the praise of the beauty of the rivers of their land, but times have changed; Greece has been deforested, and her streams—the beauty and the noble flow of whose waters was probably at all times a little exaggerated by poetic inspiration—are now but torrents whose beds are completely dry during a good part of the year. It is therefore not a little surprising to hear of the installation of a hydro-electric plant in a country so deficient in water power—to think of dynamos humming at the foot of Mount Helicon, and triphase currents encircling Parnassus—to associate a modern electric-power station with the traditions of Lake Copaïs, once famed for its eel fisheries, or of the River Cephissus, especially loved by the poets.

Just there, however, at the foot of the mountain of the Muses, Ganz of Budapest has installed a 5000-volt triphase power station for the account of the English company which has undertaken the drainage of Lake Copaïs. It replaces a temporary installation of Gwynne pumps used for some years past for drawing off the waters of Lake Copaïs from those low lands which were sunken below the level of the drainage channels. The limited capacity of the pumps, however, and the enormous cost of fuel for operating them, suggested resort to the utilisation of the waters of the lake itself, by transforming the water power of a fall into electric energy. The idea was conceived by Mr. Steel, and has proved entirely practicable. The waters, for centuries idle, which Lake Copaïs receives from the northern and eastern flanks of Parnassus, from the north slope of Helicon, from the many little girdling hills which surround it, and from the River Cephissus and scores of winter torrents—these will now be put to the prosaic work of driving dynamos as they pass, by a tunnel, to Lake Likeri with a fall of 8 or 9 metres.

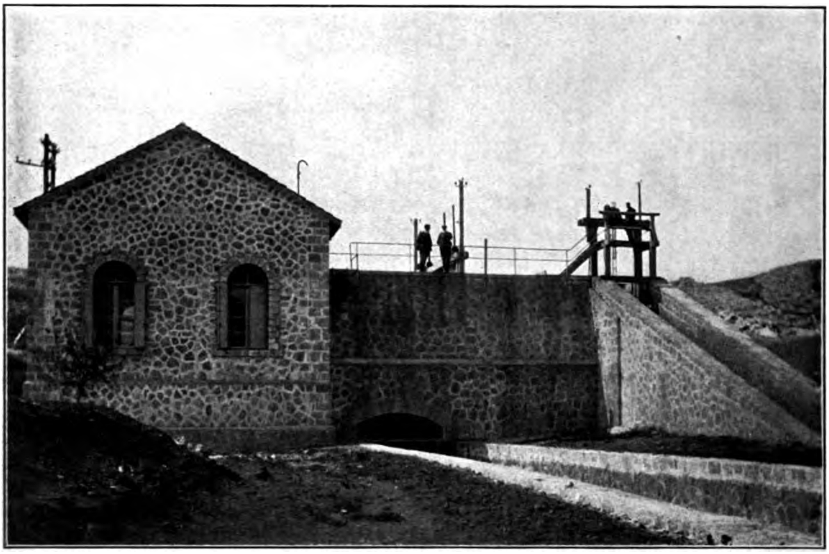
Near to this fall has been placed the power house, built of field stone cemented with pozzuolano and in parts with portland cement. It contains two Francis turbines, built by Ganz, for a fall of 7 or 8 metres. They are virtually duplex, and have a common discharge. The guaranteed efficiency is 80 per cent when the flow is full or not



VIEW OF THE POWER HOUSE AND HEAD RACE.

below three-quarters, and 75 per cent with a flow of half the normal volume. The regulation is effected from the power room by means of levers.

The turbines are direct-coupled to two Ganz triphase alternators of 130 kilowatts at 210 revolutions. The potential between each two phases is 5,000 volts. The poles of the field are of steel, with copper-band winding; the winding of the stator is star-connected and insulated with micanite tubing. The exciting current is furnished by a four-pole exciting dynamo placed on the extension of the main shaft.



THE POWER HOUSE, WASTE WEIR, AND TAIL RACE.

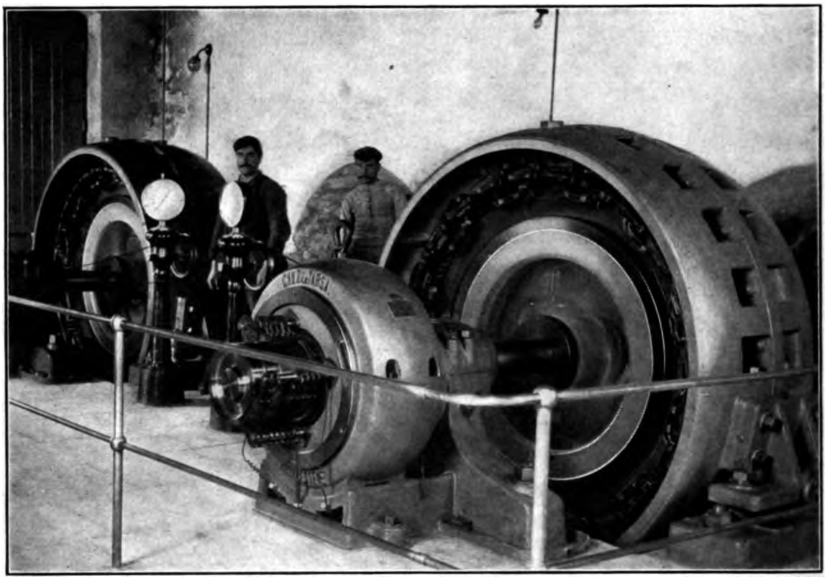
The current is led from the alternator to the distributing switchboard by conductors supported on porcelain insulators and carried through an underground conduit. The same precaution is observed in the receiving station. In both stations, also, all the iron parts of the distributing switchboard and of the machinery are carefully earthed. The switchboards themselves are provided, front and rear, with wooden platforms resting on large porcelain insulators. All the parts carrying high-tension current are consigned to the back of the switchboard. The circuit breakers are three-pole, rapid-break type; the fuses are contained in fibre tubes encased in massive ebonite.

The current is taken from the central station to the pumping station by a line of three electrolytic-copper wires supported on creosoted poles—the outlines of which are enough to raise the hair of the archaeologist (if he had any), and of the aesthete (who always has plenty). Be that as it may—the wires are 6 square millimetres in section and are carried on quintuple-petticoated insulators. Two of the insulators are placed on one side of the pole, and the third on the other side at mid-height between the two. Each pole is sunk 1.75 metres in the ground and rises 7.65 metres above it. At a distance of 1½ metres below the 5,000-volt line is placed the telephone line, well insulated and crossed every half-dozen poles. The effects of induction are entirely avoided.

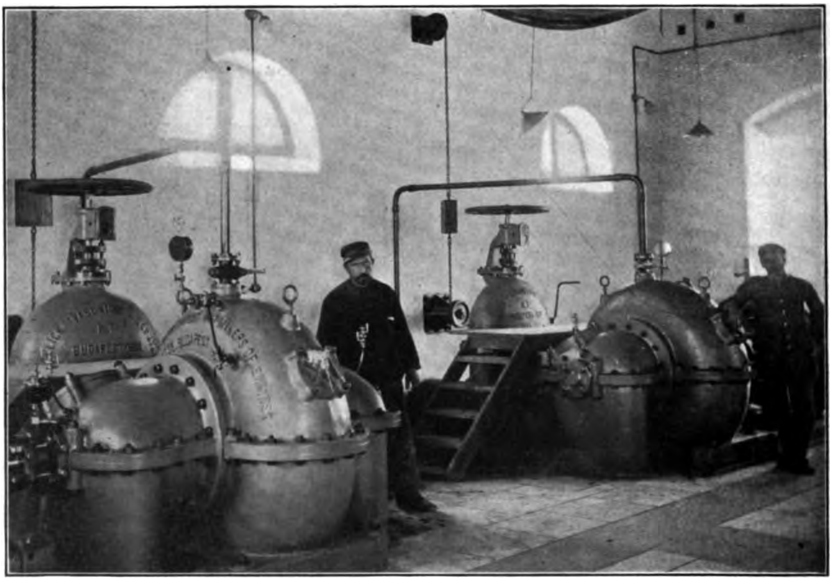
The end of the triphase line is equipped with lightning arresters of the horn type. Entry to the station is made by two poles, anchored to the wall, and large tubes of micanite. Although the distance between the two stations is 13 kilometres, the loss in the line is only 6.3 per cent.

THE DISCHARGE SIDE OF THE PUMPING STATION.

The pumping station proper is built of the same materials as the power house. It contains two triphase motors of 80 brake horse power each, running at 490 revolutions a minute; they are driven directly by the 5,000-volt current, without any preliminary transformation. Direct-coupled to them are the centrifugal pumps, raising 760 litres of water per second to a height of 4 metres. The control and operation are so simple that it is possible to employ as workmen those having no experience at all with electric machinery.

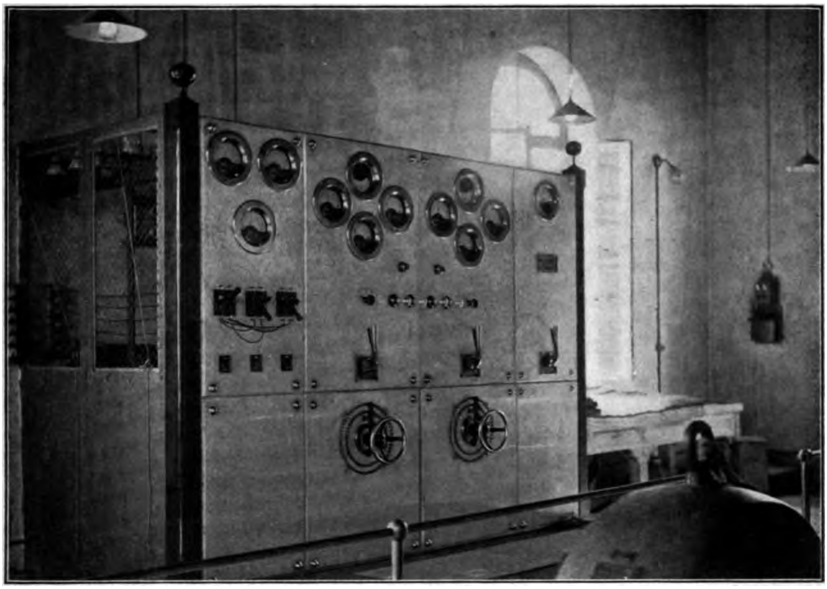


INTERIOR OF THE POWER HOUSE, SHOWING THE GENERATING MACHINERY.



INTERIOR OF THE PUMPING STATION.

The use of the electric power generated at the turbine station is not limited solely to the operation of the pumps, though that was the chief object of the installation. It serves also for certain agricultural uses, for the lighting of several offices, and for driving a number of small machines. It is thus completely utilised.



THE MAIN SWITCHBOARD.

Important results are expected from this plant, especially hygienic results to be secured by the removal of the stagnant water from the low grounds spoken of at the beginning of the article. Although an installation of this sort in one of the spots most celebrated in ancient history and fable may appear an anachronism—a just cause for grief to the Hellenist—it is nevertheless to be welcomed and its successful accomplishment regarded as a reason for felicitation, since it has a worthy humanitarian purpose and result. This is the promotion of public health by the removal of the stagnant waters and the mosquitos which bred in them. And further, it affords an example of the profitable turn which may be given to conditions apparently most unfavourable to the economical generations of electric power.

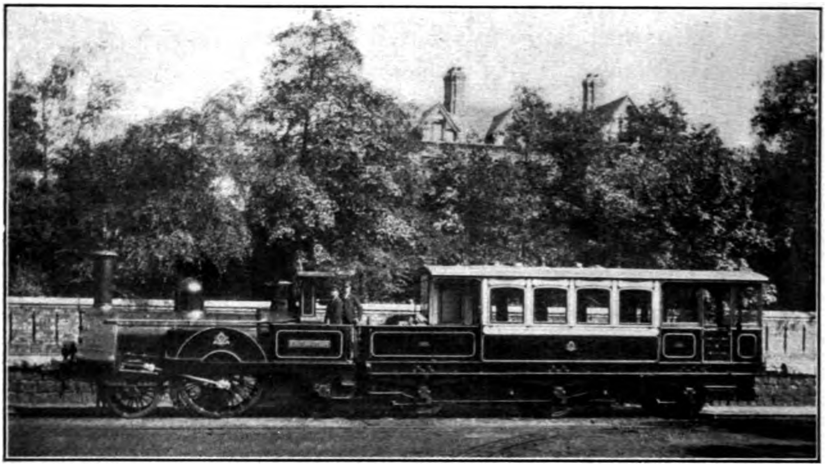


FIG. I. INSPECTION ENGINE AND SALOON, LONDON & NORTH WESTERN RAILWAY.

LOCOMOTIVES FOR SPECIAL SERVICE ON BRITISH RAILWAYS.

By J. F. Gairns.

IN a general sense, every locomotive owned by a railway company is a money-making machine; its success or non-success is judged by the load it can pull, its economy in working, its immunity from accident, the lightness of its repair bill, and its generally satisfactory character, all being considered from a dividend-earning point of view. This, however, does not strictly apply to every engine working in regular service, for on the British railways there are many engines, some of modern build and special design, others old engines fulfilling a useful purpose in their declining years, whose earning power is *nil*, and which do not directly add a penny to the receipts of the railway which owns them either by conveying booked passengers or paid-for goods. A few of these engines, together with some others designed and used for special service, will be described in this article.

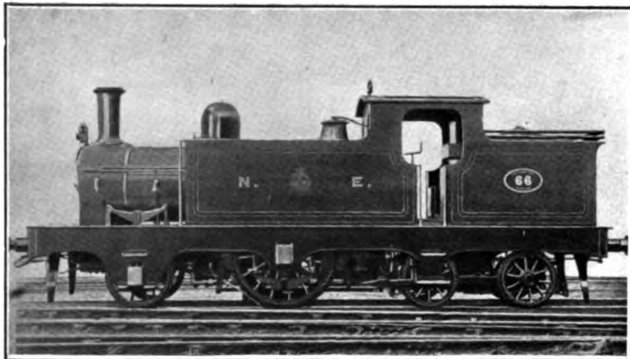
Locomotives which are designed for regular service are not always suitable for the special and private duties which form part of the operations of every railway company, and accordingly, on many lines, locomotives are built, or converted, to meet these requirements. To this class belong "inspection" engines, "crane" engines, and "works" engines, and these will first receive attention.

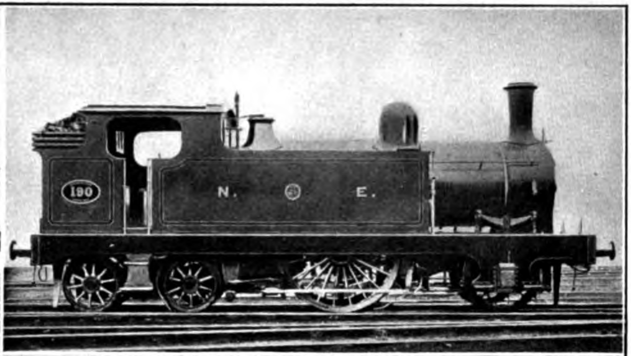
On all lines, periodical inspections of the whole system are made by the directors and head officials, and occasional trips are also made for special purposes, such as inspections by Board of Trade officials and the like. On these journeys it is not always convenient or possible to use the regular trains, and while many railways use for such duty any engine which is available, or employ a particular engine of ordinary design, to haul a directors' or official saloon wherever required, a few lines have provided special engines or combined engines and saloons for this work.

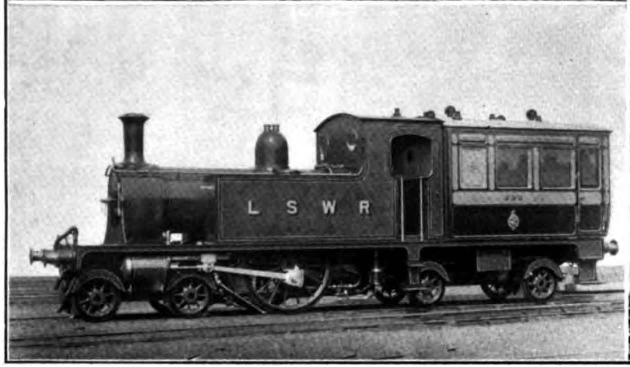
These inspection engines are in most instances old engines, too old for regular service but quite capable of doing inspection work, fitted or altered as required; but in other cases they are specially built for inspection purposes.

In Figure 1 I illustrate, by the courtesy of Mr. F. W. Webb, the late locomotive superintendent of the London and North Western Railway, the inspection engine belonging to Britain's "premier" railway. This interesting machine is actually an old "Trevithick" 6-feet single-driving engine, but instead of being broken up, as have all its *confreres,* it has been provided with a six-wheeled "coupé," the front portion of which forms a bunker for coal and water (these engines do not burn very much fuel or use much water, as the load is always light), while the rear is fitted up as an open observation platform, the middle portion forming a well fitted up saloon. The "Locomotion" as it is named, is usually driven by one of the most experienced drivers, who is familiar with the signals, running restrictions, and the conditions existing over the whole system, so that he can go anywhere and everywhere as required; and it is sufficiently speedy to be able to keep clear of even the fastest expresses on the line, while it can, if need be, haul another saloon when more accommodation is wanted than is provided by its own saloon. Usually this engine is reserved for the use of the locomotive chief. It was converted and prepared according to the designs of Mr. Webb.

On the North Eastern Railway there are two inspection engines, one for the service of Mr. Wilson Worsdell, the locomotive superintendent, to whom I am indebted for photographs of both, and the other for the use of Mr. C. A. Harrison, the engineer of the line. Mr. Worsdell's engine, No. 66 (Figure 2), is an old engine very much altered. Until a short time back this had a leading bogie and the single carrying axle was trailing; it had a copper-topped chimney and a neat front







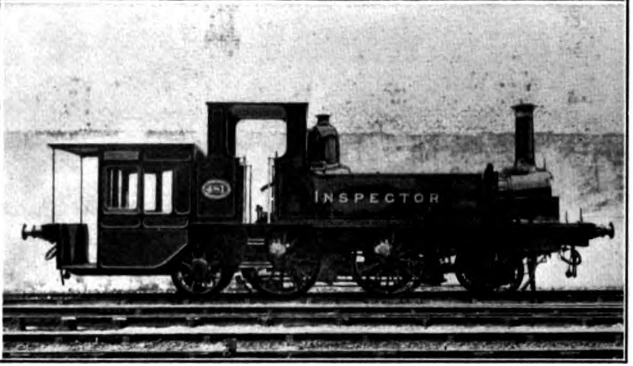


FIG. 2. MR. WORSDELL'S INSPECTION ENGINE, N. E. R.
FIG. 5. MR. DRUMMOND'S INSPECTION ENGINE AND SALOON, L. & S. W. R.

FIG. 3. MR. HARRISON'S INSPECTION ENGINE, N. E. R.
FIG. 4. OLD INSPECTION ENGINE, WITH COUPÉ ON ENGINE FRAME, L. B. & S. C. R.

frame extension, which, together with the bright brass axle-box casings still upon it, gave it a handsome and striking appearance. Recently, however, it has been rebuilt, as illustrated, the leading bogie and trailing axle being transposed, and a larger bunker provided, the engine being also otherwise altered to conform more to North Eastern practice. Mr. Harrison's engine, No. 190 (Figure 3), has all along possessed the same wheel arrangement as No. 66 now has, and was, I believe, specially built. No. 66 has 6-feet driving wheels, and No. 190, 6-feet 6-inch wheels. In work, a single saloon with the rear observation platform is hauled. I have been informed that either of these engines can be started three minutes in front of the fastest express on the line without risk of causing delay to it.

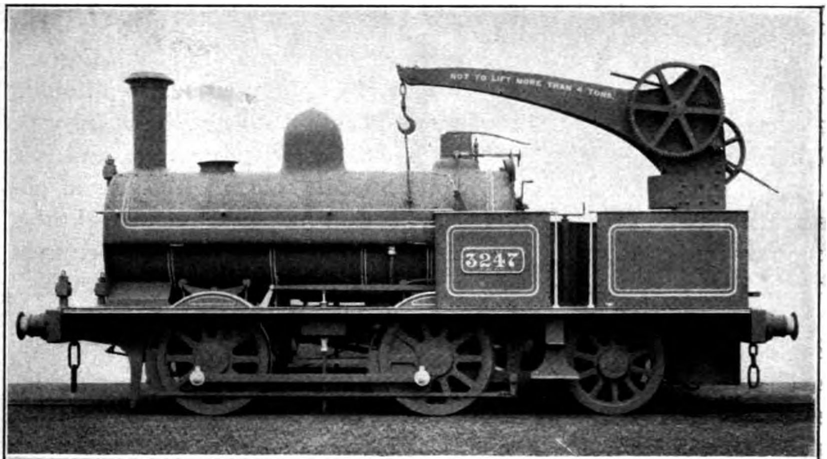
A good many years ago the late Mr. Stroudley rebuilt an old tank engine belonging to the London, Brighton & South Coast Railway, with a rear coupé compartment attached to the engine frame for inspection purposes, and appropriately named it "Inspector." This did good work for a long time, but was broken up a few years ago, since which time no special inspection engine has been in use on this line. I am indebted to Mr. R. J. Billinton, the present locomotive chief of the line, for the interesting and valuable photograph from which Figure 4 is prepared.

A very similar machine was, and may be still, in use on the North British Railway, but this I am unable to illustrate.

To Mr. Dugald Drummond, the able motive-power chief of the London & South Western Railway is due the only specially designed absolutely modern inspection engine in England, and this is shown in Figure 5, photograph having been kindly supplied by the designer for the purposes of this article.

This pretty little combined engine and saloon has 5-feet 6-inch single driving wheels, and has in addition a leading engine bogie and a long-wheel-base bogie supporting the saloon portion. In the front section of the saloon there are two small compartments—one for an attendant who can communicate with the driver through the opening which can be clearly seen in the illustration, the other being a well-fitted lavatory. The saloon itself will comfortably accommodate about eight persons. I can vouch for the excellence of its design and fitting-up by personal inspection. A special shed is provided for it at Nine Elms locomotive depot, and by the officials there it is considered the "pet of the line."

On all other British railways, so far as I am aware, no specially designed locomotives are employed for inspection purposes, though



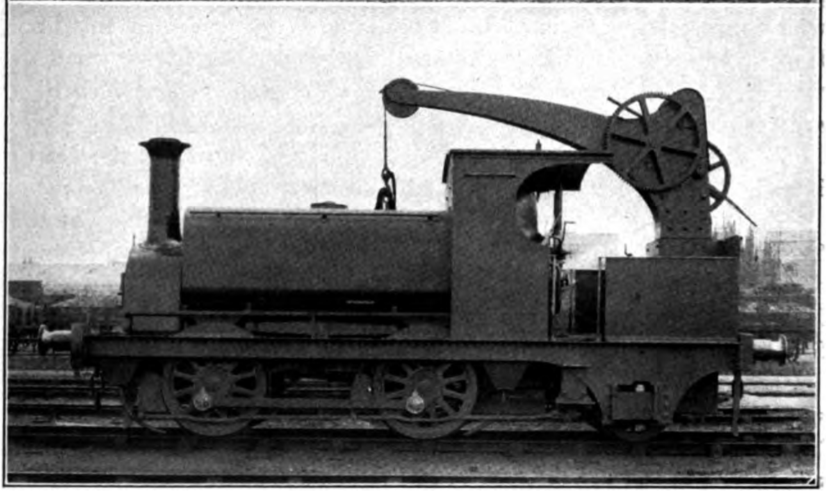


FIG. 7. LOWER PICTURE. CRANE LOCOMOTIVE, NORTH LONDON RAILWAY.
FIG. 6. UPPER PICTURE. CRANE LOCOMOTIVE, L. & N. W. RAILWAY.

Engine cylinders 14 inches diameter by 23 inches stroke; coupled wheels 4 **feet diameter; trailing** wheels 3 feet 6 inches diameter; wheel base, total, 14 feet 9 inches. The crane is capable of lifting 4 tons, and is worked by two steam cylinders, each 4½ inches diameter and 6 inches stroke. It is easily worked by the driver, who can with one lever raise or lower a load as desired. The lifting speed for light loads is at the rate of about 50 feet per minute, and for heavy weights about 14 feet per minute.

in some cases particular engines, usually old ones, are reserved for hauling the official saloons. Thus, on the Caledonian Railway, No. 123—Mr. Drummond's 7-feet single express engine, whose exploits in the 1888 race to Edinburgh are still remembered—is ordinarily used for inspection purposes, and on the Lancashire and Yorkshire Railway, two 6-feet 6-inch four-coupled engines belonging to a class now too weak for main-line work are generally employed.

The crane locomotive is a very useful combination machine, of which representatives are owned by several British railways. Such engines are only exceptionally used on the running lines of a railway, as they are intended for use about the works and in shunting yards, but they are often sent out with the "breakdown" train, unless the distance to be travelled is considerable or the accident is serious and it is necessary to send a big crane. By this means the ordinary crane which forms part of the breakdown train can in many cases be dispensed with. The crane locomotive is also very useful for working permanent-way or relaying trains.

In the usual way, the crane engine is used for shunting or in conveying parts from one shop to another at the works; but when lifting is required, sometimes in loading and unloading its own train, the crane portion can be quickly and conveniently brought into use without it being necessary to fetch an ordinary crane.

Figure 6 illustrates the London and North Western crane engine as used at the Crewe Works. The coupled wheels are 4 feet in diameter and the locomotive cylinders 14 inches diameter and 20 inches stroke, the coupled wheel base being 8 feet 3 inches, total 14 feet 9 inches. The crane is capable of dealing with loads up to 4 tons and is worked by two steam cylinders, supplied from the locomotive boiler, each 4½ inches diameter and 6 inches stroke. The lifting speed for light loads is at the rate of about 50 feet per minute, and for heavy weights about 14 feet per minute. The crane is easily worked by the driver, who can with one lever raise or lower a load as desired.

It will be noticed, on examining the photograph, that between the coupled wheels, rods are fitted; these when pressed downward grip the permanent way, thus giving the necessary stability when the crane is in use.

In Figure 7 I am enabled, by the courtesy of Mr. Price, the locomotive superintendent, to illustrate the North London crane engine. This diminutive machine, for it is very small, is yet a very useful engine. The engine is of a type which has long since ceased to exist on the North London Railway, and is a characteristic example of the utilisation of an old machine which would otherwise have been scrapped long ago. This engine is also noteworthy because of the fact that, as will be seen from the figures, equalising levers are used for the coupled wheels, this being a practice usual in America, but not in great favor in Great Britain.

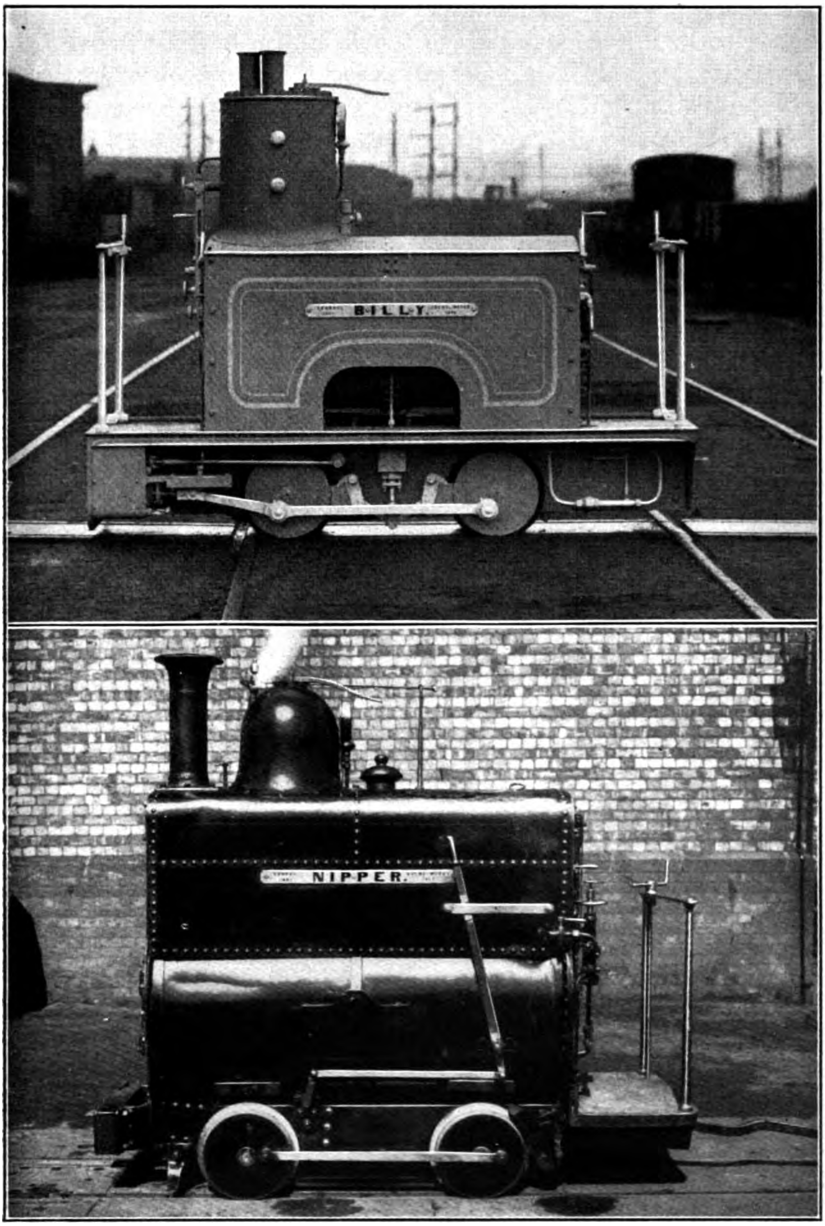
The Great Eastern Railway possesses three crane engines, all stationed at Stratford, and known as "C," "D" and "E" respectively. The Lancashire & Yorkshire Railway also possesses one or more of these useful machines.

In a big locomotive works there is constant necessity for the conveyance of material from one shop to another, so that many of the more important British railways have built locomotives specially for such service. Figure 8 illustrates one of the first "works" locomotives, designed for use on the very extensive lines of 18-inch gauge which are laid throughout the Crewe Works of the London and North Western Railway. This locomotive and its fellows are queer-looking machines but are, nevertheless, very useful. The design dates bach to 1862. The cylinders are 4½ inches diameter and 6 inches stroke, the coupled wheels being 16 inches in diameter, and the wheel base 3 feet.

It is one of these engines which is represented in one of the two well-known locomotive versions of Landseer's picture, "Dignity and Impudence," standing alongside "Cornwall," the old and famous 8-feet 6-inch single driving express engine; the other is a photograph showing a somewhat similar engine belonging to the Lancashire and Yorkshire Railway (to be described hereinafter) next to one of the big four-coupled engines.

Since the engines of the "Nipper" class were built, Mr. F. W. Webb has designed another class of engine for the Crewe narrow-gauge lines, and Figure 9 illustrates one of these. As will be seen, these locomotives are peculiar in design: they are double-ended, and can be driven from either end, and the chimney, in two sections, passes up through the steam dome itself. The outside cylinders are 5½ inches diameter with a 6-inch stroke, and the coupled wheels are 16 inches in diameter spaced 3 feet apart. The first of these was designed in 1875. In the photograph the brake gearing, operated by a small steam cylinder, is very clearly shown.

It is generally agreed that the Crewe Works are the most complete in the world, but the works of the Lancashire and Yorkshire Railway at Horwich, though smaller, constitute a good second, and as they are of comparatively recent date and specially designed for the requirements of a big railway, instead of having grown in the course of many



FIGS. 8 AND 9. NARROW-GAUGE LOCOMOTIVES USED IN THE CREWE WORKS, L. & N. W. R.

The lower one (Fig. 8) is the older type.

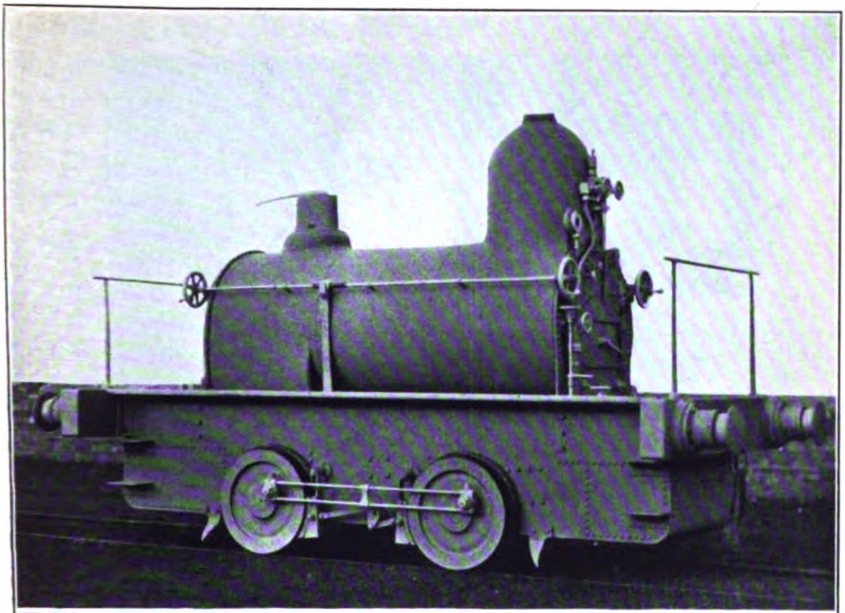
years from a small beginning, they are probably more convenient and orderly though less extensive and complete than those at Crewe. At Horwich, also, are many miles of 18-inch tramway, on which work strange-looking little engines conveying material from one shop to another. One of these engines is illustrated in Figure 10, the photograph having been kindly supplied by Mr. H. A. Hoy, the locomotive superintendent of the line. These locomotives were designed by Mr. Aspinall, the late motive-power chief, and now the general manager. The leading dimensions are as follows:

Cylinders	5 inches diameter, 6 inches stroke.
Wheels	16¼ inches diameter.
Boiler: diameter	2 feet 3 inches.
length	5 feet 2 inches.
Firebox: length inside	2 feet 3¼ inches.
diameter inside	1 foot 5⅞ inches.
Tubes (54), outside diameter	1 7-16 inches.
Heating surface: tubes	40.64 square feet.
firebox	7.22 square feet.
grate area	1.78 square feet.
Weight in working order	3 tons, 11 cwt., 2 qrs.
Tank capacity	76½ gallons.

Figure 11 illustrates another London and North Western engine which though not exactly a works engine, must be included in this section. It represents an engine of a class which is very useful in big shunting yards. The gauge is, of course, in this case standard. The chimney passes up through the steam dome, thus giving the engine a very un-locomotive-like appearance, and provision is made for operating from either end. The coupling rod of bar construction is worthy of notice. The wheels are 30 inches in diameter, and the cylinders are 9 inches in diameter with a 12-inch stroke. The total weight in working order is 15 tons 3 cwt.

The remaining engines to be described belong to the orthodox and money-earning classes, but are special in that they are designed for particular uses and with regard to particular requirements.

The four-coupled shunting engine shewn in Figure 12 was designed by Mr. Webb specially for shunting operations in private sidings and yards connected directly with the L. & N. W. R. system where the curves of the lines are often, of necessity, very sharp—so sharp, indeed, that it is almost impossible for an ordinary locomotive to go round them without risk of derailment. The peculiar feature of this engine is the trailing carriage for the rear wheels. The axle is mounted



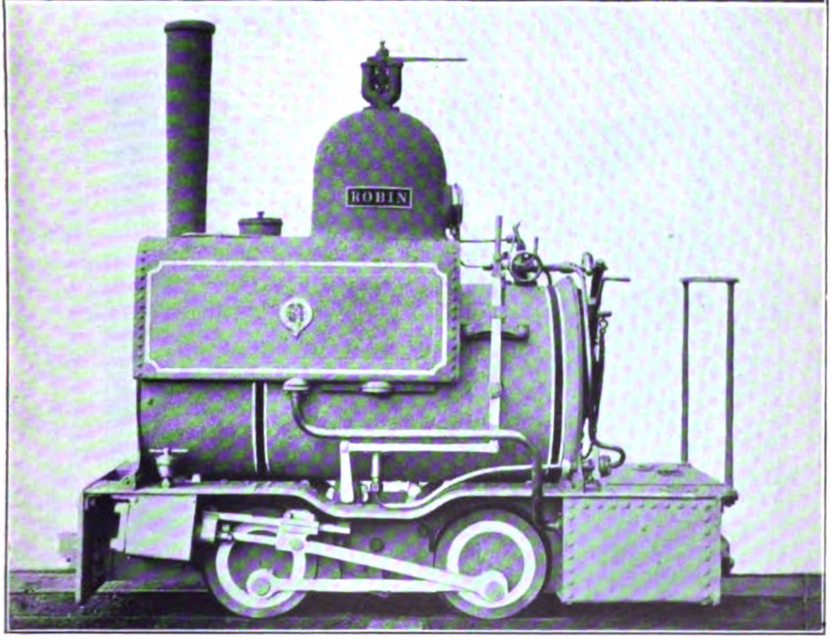
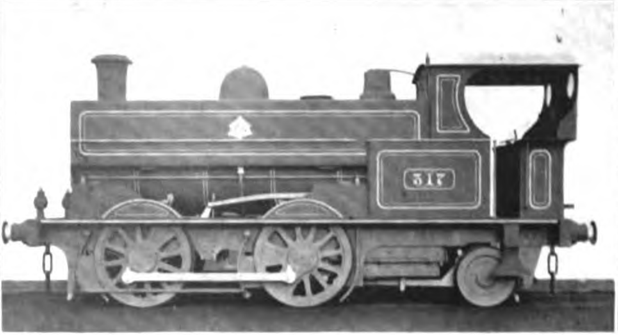
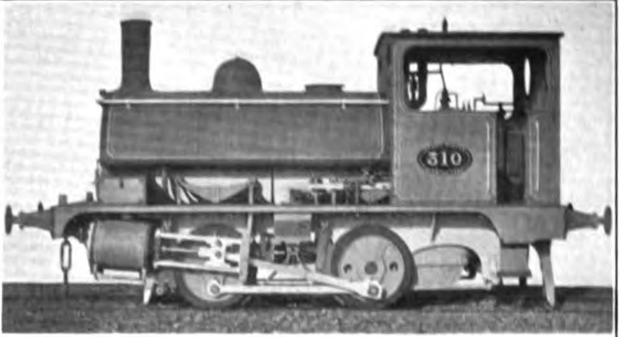
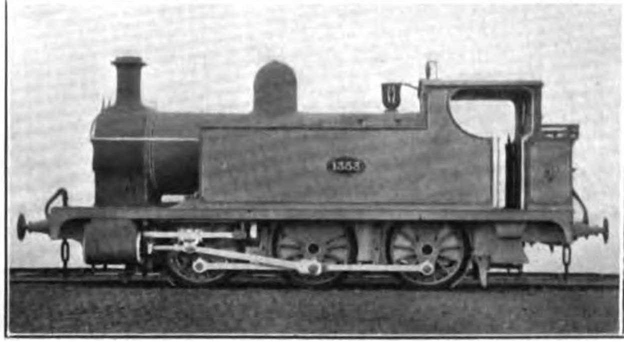


FIG. 11. UPPER PICTURE. STANDARD-GAUGE, YARD SHUNTING ENGINE, L. & N. W. R.

FIG. 10. LOWER PICTURE. TRAMWAY ENGINE, 18-INCH GAUGE, LANCASHIRE & YORKSHIRE RAILWAY.







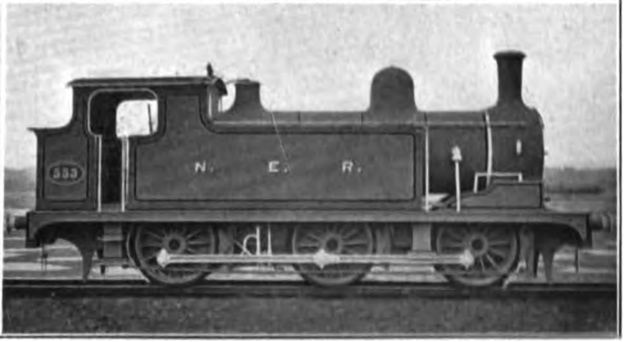


FIG. 12. FOUR-COUPLED ENGINE FOR SHARP CURVES, L. & N. W. R. FIG. 13. FOUR-WHEELED SHUNTING ENGINE, L. & Y. R.

FIG. 14. SIX-COUPLED SHUNTING ENGINE, L. & Y. R. FIG. 15. STEEP-GRADIENT BANKING ENGINE, N. E. R.

in a frame which is pivotally connected to the engine frame at a point some distance towards the front, so that the axle can readily take up positions angular to the coupled axles, and thus the wheels can accommodate themselves to very sharp curves and to irregularities in the road to an extent which is impossible in the case of ordinary locomotives. The following dimensions will be of interest:

Wheels (coupled)	4 feet 3 inches diameter.
(trailing)	2 feet 6 inches diameter.
Wheelbase (fixed)	7 feet 3 inches.
(total)	15 feet 6 inches.
Cylinders	17 inches diameter, 24 inches stroke.
Weight in working order	34 tons, 17 cwt.
Weight available for adhesion	14 tons.

Figure 13 illustrates a useful Lancashire and Yorkshire shunting engine of a type which is used in the big shunting yards, and Figure 14 illustrates a larger engine such as is used for shunting both in goods yards and at passenger carriage sidings, and also for local goods service.

The leading dimensions of these two engines are as follows:—

	4-wheels coupled engine.	6-wheels coupled engine.
Cylinders: diameter	13 inches.	17 inches.
stroke	18 inches.	24 inches.
Wheels (all coupled) diameter	3 feet ⅜ inches.	4 feet 6 inches.
Wheelbase	5 feet 9 inches.	12 feet.
Weight in working order	21 tons 5 cwt.	50 tons.
Boiler: diameter	3 feet.	4 feet 2 inches.
length	8 feet 10 inches.	10 feet 4¾ inches.
Firebox: length	2 feet 10 inches.	5 feet 6 inches.
width	3 feet 9 inches.	4 feet 1 inch.
height	4 feet 3¾ inches.	5 feet 1 inch.
Tubes, diameter (outside)	1¾ inches.	1¾ inches.
number	104.	220.
Heating surface: tubes	432.75 square feet.	1081.5 square feet.
firebox	43 square feet.	85.9 square feet.
firegrate	7.2 square feet.	17 square feet.
Tank capacity	450 gallons.	980 gallons.
Coal capacity	14 cwt.	2 tons.

In addition to the locomotives above described there are, of course, many engines which are specially designed, say for working heavy and fast express trains over particular sections of the line, or for dealing with very heavy goods or mineral trains, but these are strictly outside my subject.

I, however, illustrate, in conclusion, by Figure 15 a large North Eastern tank engine designed for working over very steep gradients. These engines were designed by Mr. T. W. Worsdell, the late locomotive superintendent, for banking on two of the most difficult inclines on the system, the one at Redheugh (Gateshead) with a gradient principally of 1 in 22 connecting the extensive mineral lines on the south side of the Tyne in the district known as the "Teams" with the main lines just by Gateshead station, and the other on the north side of the river close by the Manors station connecting the Quayside lines with the main lines. The latter of these lines is partly in tunnel, and the gradients in both cases necessitate very severe work on the part of the locomotives. I have seen mineral trains ascending the Redheugh incline with two ordinary six-coupled goods engines in front, and one of these big tank engines at the rear, all working at full power. These tank engines are little known and are rarely seen by passengers, for they work on sections which are devoted entirely to goods and mineral traffic and are removed from the main passenger lines. I am unable to give the dimensions of these powerful engines.

There are a few other locomotives in Great Britain which come within the purview of this article, but sufficient has been said to show that the locomotive engineer is not alone concerned with the designing of engines for working passenger and goods traffic, but has also to design, occasionally, special locomotives, of which the principal and most interesting examples have been set forth above.

I would express my thanks to the various locomotive superintendents who have so kindly furnished particulars of their special locomotives as described above, and for the photographs, all of which are official, with which this article is illustrated.

THE POWER PLANT AND MECHANICAL EQUIPMENT OF APARTMENT HOUSES.

By Percival Robert Moses.

The apartment house, as it has been developed in the United States, is a really remarkable assemblage of engineering appliances and processes, requiring the exercise of an equally comprehensive range of engineering skill in its design and maintenance. Mr. Moses' general definition of the field will be followed shortly by a significant paper by Mr. R. P. Bolton, dealing very plainly with certain abuses of professional ethics in connection with the construction of these plants, for which the architectural profession is responsible and from which the engineer, the owner, the manufacturer, and the public are alike suffering.—The Editors.

THE congested conditions of cities, together with the increased demand for conveniences and comforts, has forced the development of the modern apartment building. The most complete development of the idea of centralization is found in the United States in the so-called apartment hotel, where not only the supplies of heat and light and general service are taken care of by the owner of the building, but the kitchen, laundry, and general care of the individual apartments are also controlled from the same source, and the tenant has only to pay his bills.

The two main divisions of high-class apartment houses are therefore the housekeeping type and the non-housekeeping or hotel type. The buildings of the better class are from ten to twenty stories in height, from one to two stories below the ground, and cover plots from 50 by 100 to 200 feet square. Buildings are finished in some cases by a roof garden enclosed or partly enclosed.

Rooms are heated by steam radiators, and in one or two instances by hot air, delivered from a forcing apparatus in the basement, through ducts to the separate apartments and halls. They are lighted by electricity, lights being grouped in clusters in the center of the rooms and at localized points on the side walls and partitions. Electric bells from the rooms to a central point in each apartment, and from front and service doors and from tables in the dining rooms, are installed and operated from a central point by a small dynamo in the basement. Hot and cold water are supplied to all bath rooms, kitchens, and frequently to the separate rooms, although the tendency is to place bath rooms between pairs of rooms, doing away with the individual wash stands. In one large apartment, filtered salt water will be supplied for baths.

Provision must be made for removing waste of all kinds, such as garbage, papers and refuse. High-speed elevator service is of course a necessity, and the elevators are divided into passenger elevators for the service of the tenants and their friends, and service elevators carrying the servants, tradesmen, and luggage. Mail chutes are provided, so that letters can be mailed at each floor by merely dropping them into a slot; and in some buildings pneumatic delivery tubes carry mail, newspapers, small parcels, and visiting cards to the separate floors, whence they are delivered to the tenants. Each apartment has its telephone connected to a central station on the first floor, which connects it with the general telephone system of the country.

In housekeeping apartments, gas is supplied for cooking, each tenant paying directly for this, or in one instance electricity for electric cooking apparatus is supplied at a fixed charge per month. Cold-storage boxes are placed in each pantry, and these are cooled by salt or calcium brine circulated through coils in the boxes by pumps in the engine room, the brine being maintained at a temperature of from 0 to 10 degrees F., and frequently fresh water cooled to 40 degrees F. for drinking purposes is circulated. As the tenants have part of their laundry attended to by their own employees, washing facilities are provided in the basement with tubs, clothes boilers heated by steam supplied from the plant, and electric or gas-heated irons.

In the hotel apartment, as there are no kitchens in the individual apartments, steam is supplied to one or more main kitchens for cooking and other apparatus; large cold-storage refrigerators are cooled in the same manner as the small ones in housekeeping apartments, and ice is made for table and other uses. The laundry apparatus is operated mechanically, usually by electric motors, and includes steam-heated mangles for ironing, centrifugal driers, etc. The main kitchens are equipped with bains marie, vegetable and stock kettles, plate warmers, dish-washing machines in which the dishes are lowered and raised in wire baskets mechanically and cleansed by a steam-heated solution, and other cooking apparatus. Occasionally electric-plating apparatus for the plated ware is installed, electric-driven printing machines for printing *menus* and other literature connected with the building, and electric-driven knife-grinding and polishing machines—in fact, everything required for conducting the business of the hotel with the least recourse to outside sources.

The rental value of such apartments is high, and varies from $20 a room per month up to $75 a room per month; the non-housekeeping apartments being naturally more expensive than the housekeeping.

The tenants demand the best service, and every provision must be made to prevent interruption of this service, as a serious breakdown might not only cause heavy loss in rentals, but loss of life.

The heart of these immense buildings is the power plant, and the supply feeders for steam, electricity, water, and brine may be compared to the arteries of the body. The keystone of the power plant is the steam-generating system. This system consists of steam boilers, either of the return-tubular or of the water-tube type. The return-tubular type is generally used for steam pressures of 115 pounds or less, the water-tube for pressures above this. The number of boilers is proportioned to the requirements of the building. There should always be at least one spare boiler, to allow cleaning of the others; but in general the number should be kept as low as consistent with economical use of the fuel during the different seasons, as it is axiomatic that the more pieces of apparatus there are to be taken care of, the more labor will be required to take care of them. Small sizes of steam coal are ordinarily burned under these boilers, known to the trade as pea coal, No. 1, 2, and 3 buckwheat. The last two can be burned economically only with forced draft. The grate surface of the boilers should be proportioned to allow 1 square foot of surface to from 3 to 4 boiler horse power—i. e., about 1 square foot of surface to 100 pounds of water evaporated per hour. It is not the purpose to enter into the details of a boiler specification in the limited space of this paper, but this ratio of grate surface is mentioned as several instances have lately come to the author's notice where the entire equipment has been seriously handicapped by the use of grate surface half the size required by the other proportions of the boilers.

Steam is supplied from these boilers at 100 to 150 pounds pressure, depending upon the size of the plant and the other uses of steam, and is delivered through main wrought-iron pipes to the engines connected to the electric dynamos, steam cylinders of pumps, and at a reduced pressure for heating and other low-temperature purposes. In a paper written for THE ENGINEERING MAGAZINE in October, 1898, entitled "Use of Steam and Labor in Isolated Plants," the best method of using the steam was fully treated. It will be sufficient here to note that the steam is first used expansively in the engines, etc., taking a few per cent. of the heat units available and allowing the pressure to drop from its initial to 2, 3, 4 or 5 pounds as required. This portion of the energy of the steam is used for producing power, after which it enters the heating system, the drying coils in the laundries, and the heater for the water fed to the boilers. In these it loses its latent heat and becomes condensed and returns to a receiving tank, whence it is pumped and returned to the boilers, thus utilizing all the heat units obtained from the coal.

Other uses for this low-temperature steam have developed, one of which is in the production of refrigeration, the steam being passed through a distilling retort of the absorption type of refrigerating machine, as will be described a little later.

The steam-pipe system may be said to consist of high-pressure supply, exhaust mains, heating supply and risers, return from heating system, and the drip mains. The high-pressure piping is the one requiring the greatest care, as it is subject to wide extremes of temperature as well as to higher pressure. In general, the standard-weight pipe is amply strong for any pressure up to 150 pounds, but for all pressures above 100 pounds and for pipes larger than 4 inches in diameter, the connections between the ends of pipes or between pipes and valves should be made with extra-heavy flanged fittings. It is my custom to specify that flanges shall be placed on pipes, pipe being brought flush with the face of the flange and then peaned over to make a tight joint, after which the whole is placed in a lathe and the face of the flange trued up. It is a good thing to have these flanges fitted with male and female rings for the higher pressures. For pressures under 100 pounds where the pipe is long the joints should be flanged, but the flanges need not be extra heavy. Connection by couplings for high-pressure work on long lines is distinctly bad practice, as once a serious leak develops, it is impossible to make it tight without taking down the whole main. For low-pressure piping, the standard-weight pipe and fittings are satisfactory. Wherever a branch is taken from a main, whether it be high-pressure, low-pressure, or drip, it should be valved close to the main; otherwise if a leak develops the whole main must be shut off to make the repair, and power plants of some of the largest buildings have had to be shut down completely, merely to allow a drip pipe of the high-pressure main to be repaired.

In order to avoid the possibility of shut-down, due to accident in the main steam connections, the best practice requires an auxiliary main, entirely distinct from the larger main, connected to all the apparatus required for emergency use. It is not necessary usually that this auxiliary main should be connected to all the apparatus, but only to such portions thereof as will be needed for operation for a few hours, pending repair of the large main. Entrained water is most frequently the cause of trouble in high-pressure piping, and can be prevented only by the most careful dripping at frequent intervals. In dripping a long main, the drips from opposite ends of the main should not be connected together, except through separate traps, otherwise the reduced pressure at the end of the main will not be sufficient to force the drip back against the pressure at the other end, and water will accumulate.

Proportioning the steam pipes leading from the boilers to the engines and other apparatus is of great importance for the economical operation of the plant. At the same time, in high-pressure piping the limits between good practice and the least size that will do the work are quite large, and in one instance where a main 12 inches in diameter was required for proper operation, a 7-inch line was installed temporarily and did the work satisfactorily, although of course with heavy drop in pressure. The size of the pipes is determined by the allowable velocity of the steam in them, and this will be influenced largely by the number of bends, the length, the danger of entraining water from the boilers, and the character of the engines which they supply. As is well known, a right-angle bend in a pipe offers as much resistance as several hundred feet of straight pipe, and certain types of high-speed engines operating under rapidly varying loads will have a greater tendency to pump water over from the boilers than a slow-speed engine operating under steady conditions.

All piping, high- and low-pressure, must be insulated and supported. Insulation for high-pressure piping cannot be too good; in addition to the insulating qualities of the material, its power to resist vibration and high temperatures are important. Low-temperature piping can usually be insulated sufficiently well with some form of covering containing dead air spaces. In supporting the pipes it is necessary to provide for expansion and contraction, and at the same time prevent any vibration being transmitted to the steel structure of the building. It is best practice to combine a system of standards supporting the pipe from the floor with hangers insulated from the beams on which they hang by wood, etc. The exhaust main takes steam from the engines and other high-pressure apparatus using steam, and carries it to convenient points for use as before described. In order to use this steam successfully without damage to other apparatus, it is necessary that all or nearly all of the oil taken by the steam from the cylinders of the engines and pumps should be removed. Part of the exhaust steam from the plant is used for heating the feed water for the boilers. This work is performed either by allowing the exhaust steam to come into direct contact with the water, or allowing the water to flow through a coil, steam remaining on the outside and transferring its heat. The disadvantage of the latter system is that the condensed exhaust steam is wasted as well as part of its heat. The advantages are that the oil in the exhaust steam is absolutely prevented from entering the boilers, and the pumps handle the water before it enters the feed-water heater, hence in a cooler condition.

The heating system consists of mains from which steam is supplied to rising lines running up through the various apartments. In some cases where it is advisable these mains are run around the upper story, but usually they are placed in the basement or sub-basement. The systems of distribution are known as single-pipe and two-pipe, up and down feed. The essential difference is that the single-pipe system allows condensed water to run back in the same pipe that supplies the steam, and has one valve to shut off each radiator, while the two-pipe system has a separate line to drain off the steam condensed, and has a valve on the supply and a valve on the return for each radiator. In both these systems the air entrapped in radiators is relieved either through automatic air valves discharging into the room, or in best practice through air valves discharging into air lines which are carried to the basement and discharged at a convenient point. Where air valves discharge into the rooms they must be provided with a float preventing the discharge of water as well.

The single-pipe system is the least expensive to install, and if correctly designed it is satisfactory. The main requirements are to have the pipes amply large, to have as few bends as possible, and to have connections to radiators as short and direct as the necessities for allowing for expansion will permit. In other words, everything must be done to keep the velocity of the steam low. If the velocity of the steam is increased beyond well defined limits, water will be held in the radiators, and there will be a continual gurgling and hissing sound accompanied by water hammer. For tall buildings, where the condensation in risers is likely to be large, each riser should be separately dripped by a large drip at its foot, and these drips delivered to the return main, and from there run along the ceiling of the basement or under the floor. In the first case it is called dry return, and the second case sealed or wet return system. The latter is preferable where the pipes can be protected from corrosion and where conditions as to levels permit. The dry (or overhead) system, brings the pipes low in the rooms in the basement, and does not relieve the system as well as the sealed return. In the overhead system the drips from the risers leading to the return main must have check valves permitting the condensed water to flow only toward the return main. These check valves are liable to stick or to be held by excessive pressure in the return main, in which case the water of condensation will not be relieved from the riser and the system will be noisy; besides the checks themselves will cause a clicking which is transmitted through the risers to the apartments.

Where the building is large, it is sometimes advisable to install systems of heating in which a vacuum is maintained on the returns or the air lines. The systems are patented, and their main function is to reduce the back pressure to nothing, and to insure more perfect circulation of steam by removing the air and water. Where a vacuum is maintained on the returns, the size of supply and return pipes can be greatly reduced.

The required radiating surface in the room is determined from the quantity of glass surface, the exposed wall surface, and the cubic contents, taken in conjunction with the thickness of the walls and the exposure. The most important factors are glass surface and exposed wall surface. These constants have been determined empirically, and must be modified according to the care with which the buildings are constructed. A few points worth noting in the design of such systems of heating are that angle valves with removable soft seats should be used on radiators wherever it is at all possible; risers should have drip pockets provided so that the dirt which accumulates can be taken out, this applying to the air lines and returns as well as to steam supply; connections should be left where they can be reached, and wherever risers are concealed in walls, they should be insulated; radiators should be put near the most exposed surfaces, but for reasons other than heating reasons, it is preferable to keep them away from windows; provision should be made for draining out the returns after the winter season.

The engines used in apartment houses are usually high-speed, from 225 to 300 revolutions, depending upon size, and are directly coupled to dynamos. They are equipped with sensitive governors which hold the speed constant within 1½ per cent., even under momentary changes of load of from 50 per cent. to 75 per cent. of the rated capacity, with self-oiling bearings with removable shells, cylinder lubricators, gravity oiling systems by which the oil is fed to the moving parts, filtered, and pumped back ready for use again, and indicator piping. In some of the larger houses it is found economical to install a few compound engines operating at 125-pounds pressure, but in general the simple engine using the steam in one cylinder is installed. Slow-speed engines, while highly economical, require too much space. If there is room enough, and the conditions warrant, they are preferable to the high-speed engines. Three or more engines should be installed, any two being capable of carrying the full load which they will be called upon to supply; and this load can be taken as about three-quarters of the total connected installation. During the day one of them can be run, as the day load seldom reaches one-quarter of the maximum.

The supply of electricity in these apartment houses is usually obtained from dynamos directly coupled to high-speed engines without any auxiliary connection to street service, hence it is usual to have one or more spare units as in the boiler plant. Where the elevators are operated electrically, the electricity for light and power may be supplied from the same dynamos without any objectionable flicker in the lighting as the elevators start and stop, provided that the elevators are designed to keep the starting current down to the minimum required by good practice, and that the governors of the engines are of the inertia or similar type which counteract, before the actual drop occurs, the tendency to drop in speed as the load goes on.

From the dynamos electricity is delivered over insulated wires or cables to a switchboard. The switchboard is the receiving and distributing center of the electric system; it receives the electricity from the source, the instruments on it measure the quantity and pressure, and the switches control the different mains and feeders running to distributing panels on the various floors or at other convenient centers. Protective devices designed to prevent overload are located on this board. Distributing panels are miniature switchboards usually containing one switch for each circuit, the whole contained in a slate or metal-lined box and this in turn enclosed in one of wood. Where electricity is to be sold these panels are designed with meter loops.

Good practice requires that the wires shall be protected by metal pipes, which prevent mechanical injury, but do not insulate. In wiring a building, the system of pipes is first installed complete, pipes running from a location near the switchboard to wooden boxes on the different floors, and from these boxes to metal boxes called outlet boxes located wherever lights are desired; after this the wires are drawn in. Wires from the switchboard to the distributing panels are termed mains; wires from the distributing panels to the outlets are circuits. The circuits for lighting are usually two wires encased in a common insulating covering and controlled at the distributing panel by small switches, twelve lights of 16 candle power being allowed on a single circuit, the object of this subdivision being to prevent trouble on one set of lights from affecting all the others. In order to facilitate the turning on and off of lights, switches operated by push buttons are universally installed at a convenient height near the entrance of the room, and are connected to allow any desired group of lights to be turned on or off by pressing a button. Where it is desired to control groups of lights near fixtures, pendant switches operated by push buttons, are used, or switches are installed on the fixtures themselves.

All mains and circuits are protected from possible overload; i. e., from carrying more electricity than their size will safely permit, by strips of fusible metal known as fuses. These fuses are sometimes exposed and sometimes enclosed in cartridge-like cases. When the latter are used they should be designed to indicate whether the fuse is still intact. The safe limit of carrying capacity of wires is not fixed by the point at which the copper will melt, but by the rise in temperature the rubber insulation will stand continuously without deteriorating.

In distributing electricity, the same principle holds true as in steam or water. There is a drop in pressure, depending on the distance from the source of supply and on the size of the supply lines. Both from a viewpoint of economy and of obtaining good light throughout the building, this drop in pressure must be kept as low as conditions of cost will permit. It is usual and proper to allow 3 per cent. loss to the distribution panels under conditions of maximum load, with a maximum to the farthest light not to exceed 4 per cent. With any greater drop in pressure than this, the difference in the pressure between the lights near the switchboards and those farthest away would be very noticeable. On account of difficulties in the design of incandescent lamps for voltages higher than 120, this pressure is usually adopted for private plants in apartment houses. Lamps are designed for higher pressures, but economy or life of the lamps is sacrificed.

Three approved systems are in use for distributing, viz., two-wire 125-volt direct-current, three-wire 125-volt direct-current, and three-wire 240-volt direct-current. The first should be used where no outside service is required; the second, where outside service will be required for lighting only; and the third where outside service may be required for lighting and power both alternately with the plant. In the two-wire system, two wires of equal size are run together, and there is a difference in pressure between them tending to cause a flow of electricity of from 110 to 125 volts. In the three-wire 125-volt system, three wires are run, one having double the carrying capacities of the others; i. e., it is really a two-wire system with one of the wires split in two; in the three-wire 240-volt system, three wires of equal sizes are run together, and there is a difference in pressure between each outside wire and the middle wire of 110 to 125 volts, and a difference in pressure between the two outside wires of 220 to

250 volts; this cannot be used with 125-volt dynamos unless two of them are connected together. When this last system is used, the dynamos are designed for 240 volts, an automatic electric balancing device being used to keep the pressure between each outside wire and the middle wire equal. As this introduces another piece of machinery, it is advisable only where outside service for power and lights is probable. Where electric elevators are used a storage battery is frequently advisable, performing a function similar to that of a pressure tank in a hydraulic-elevator system. It has the additional function of an emergency supply in event of breakdown. Where electric elevators are not used, the cost of the battery usually makes its installation inadvisable.

Dynamos should be compound-wound, designed to raise the voltage automatically from 3 to 5 per cent. as the full load goes on. They should deliver their full capacity with a maximum increase in temperature of not more than 40 degrees C. The revolving part should be secured to the shaft by keys; set-screws are not sufficient. The commutator should be made of heavy copper bars well supported throughout their length, these bars insulated by mica and protected on the inside from any oil that may be thrown up from the engine. The slots in the armature to hold the wires should be shallow, as deep slots cause singing noises. The dynamo should be easy to inspect in all its parts, particularly around the commutator end. The brushes which collect the electricity from the commutator should be of carbon, free from hard spots, and have 1 square inch area for each 35 amperes of electricity delivered at full load. The same holds true of the elevator motors, as these are subject to heavy shocks in starting and stopping, and for this reason in the elevator motors the connection between the wire on the armature and commutator bars should be made flexible. Connections to the elevators from the switchboard should be separate from the lighting connections and separate from each other, otherwise the starting and stopping of elevators will seriously affect the running of the others and the operation of lights.

Switchboards should be of enamel slate, or, where finish is important, of marble, and should have enclosed fuses on the face of the board, an ammeter for measuring current of each dynamo, one voltmeter with a switch arranged so that voltage can be read across all parts of the system, wattmeters to record the total electricity delivered, a standard clock, and the rheostats of the dynamos.

Where electric irons or electric heaters are used, these should be connected with asbestos-covered flexible cable, and should be arranged to cut down the electricity automatically when not in use.

The location of lights and their distribution is frequently decided by the decorative effect. For good lighting one 16-candle-power lamp for from 700 to 800 cubic feet in chambers and 500 cubic feet in dining rooms is ample.

The refrigerating system consists of apparatus for producing liquid ammonia, expansion coils located in tanks to hold the liquor which it is desired to cool, a system of mains and risers through which the cooled liquor is pumped to coils in the various boxes or to ice-water faucets, storage tank for receiving and holding the cooled liquor, and ice-making tank. In order to produce liquid ammonia, two conditions are necessary—first, that the ammonia gas should be raised to a certain pressure; and second that the temperature of this gas should be lowered to a temperature depending upon the pressure; i. e., there is a certain temperature for each pressure at which ammonia gas will become liquid. There are two ways of obtaining this pressure; one is by distilling in a retort in which the required pressure is maintained, and the other is by mechanical compression. The lowering of temperature is obtained by circulating cooling water over coils into which the gas is discharged from the pressure-producing apparatus.

The first type is the absorption system, so called, as the ammonia after expanding in coils of the cooler is re-absorbed by the liquor from which it was originally driven by heating in the still. The latter system is the compression system, and in this the gas returns as gas from the expansion coils of the cooler, and is compressed to the desired pressure. The compression system is the simpler and requires less water than the absorption, but as the water used for cooling the ammonia gas is only heated up it can be used throughout the house, and it becomes a question as to the cost of the water wasted. In general, the water used in winter for the refrigerating machine will always be less than that used in the house. In summer, where the building is a housekeeping apartment, more water will be required for the refrigerating machine than will be used in the house, and the water will be heated up so that it cannot be used as cold water for baths. By properly dividing the water system, a great part of the water required for the refrigerating machine in summer can be supplied to the hot-water system and the waste reduced. In the use of steam, the absorption machine for apartment-house work is far more economical, particularly if it is designed so that distillation can be accomplished by the use of exhaust steam from the engines. No general rule can be laid down as to which is the most economical, but in the majority of cases the absorption machine will be found to cost less to run, balancing losses and gains.

In hotel apartments this is almost always the case, as a great deal more water is used throughout the house in such buildings than in the housekeeping apartments, hence there is less waste of water. The compression machine must be amply large for the work so that it may run slowly and give the valves a proper chance to seat without noise. The noise of operation of the compression machine caused a great deal of dissatisfaction with refrigerating apparatus, but with large machines and proper design, there is no necessity of any noise that can be heard outside of the engine room.

Two methods of circulating brine through the boxes are in common use. In one the brine is forced up one riser and down a return, connection to the coils in boxes going from the riser to the return, as in the two-pipe steam-heating system. In the second method, brine is forced up a single riser and comes back on another riser. At each box a valve is placed in the riser and a branch taken from below the valve on the riser to the coil in the box, and thence back above the valve, thus connecting all the coils in the boxes on the two lines in series, each coil being by-passed by the valve on the riser. This system is more positive and requires less pipe, less valves, and less insulation, where it can be adopted. The objection to it is that it entails more friction and more work on the pump, and greater increase in temperature between the leaving and returning brine. It is particularly adapted to absorption systems, as in these extremely low temperatures on the brine can be obtained with economy. With compression systems, the higher the temperature of the brine the more economical the operation.

One of the most important features of refrigerating work is the insulation of the piping. A great variety of insulations are on the market, many of which work well the first season. Even the best give trouble, unless most carefully applied. If air obtains admittance, either through imperfect sealing of joints or through a break in the covering, the moisture in the air will be precipitated by the cold, and it is only a question of time before the covering will begin to show mildew and rot. The same is true if the insulation allows the cold to be transmitted to its outside covering, making this cold. This results in the deposition on the covering of moisture from the air. Care must be taken in bringing pipes from the risers to the boxes to see that any moisture that collects on the coil in the box shall not be able to run back onto the riser. In general, brine pipes or other cold pipes should be kept out of warm places or enclosed spaces. A free circulation is desirable as it tends to dry off any condensation. The brine piping may be standard wrought-iron pipe. Ammonia piping should be extra-heavy, fitted with male and female flanges of the very best construction; nothing can be too good for ammonia work. The construction of boxes, brine, and ice-making tanks is entirely a question of cost. The better the insulation, the less expensive it will be to operate the plant. The usual insulation consists of pairs of boards with insulating paper between them, either two or three pairs, separated by spaces containing cork, mineral wool, or other insulating substances; the principal thing is to have the joints tight.

For ice-making, if clear ice is necessary, the water should be distilled and the ice made at a temperature of from 18° to 20° F. Ice about two-thirds clear, enough for most purposes, can be made from ordinary filtered water, provided the temperature can be kept at about 20° F. If a lower temperature than this is used, ice becomes cloudy and marble color. It is usually made in cans containing from 100 to 300 pounds each. Where ice water is circulated throughout the building, the insulation need not be as heavy as for the brine piping. In other respects the work is similar, except that the faucets from which the ice water is drawn take the place of coils. In some cases where it is desired to make ice in the separate apartments, the coil is a box coil, laid on its side, and a shallow pan filled with water is placed in the coil.

It is desirable that complete systems of recording temperatures and pressures should be provided; these include thermometers on the brine and ice-water inlets and outlets, gauges for ammonia, brine, and steam pressures, and salometers and hydrometers for measuring the density of the solutions. The care and operation of the various portions of the plant have been treated in previous papers on the "Determination of Costs" and on the "Systematization of Plant Operation" so these will not be touched on here. It can be readily seen that the best care and knowledge is needed for successful results and incompetence and lack of system must result disastrously.

The question as to design of elevators, the systems of plumbing and water supply, removal of waste and refuse, have merely been mentioned, and it is impossible to take them up here. Sufficient has been written, however, to show the interdependence of the various parts and the immense number of considerations that enter into the design of such equipment. It is similar to the planning of a city on a small scale, and this is not surprising if it be remembered that a building the size of the Ansonia, 200 feet square, seventeen stories above the ground and two stories below, containing three hundred and forty suites of apartments from two to fourteen rooms each, besides stores, etc. on the ground floor, contains during the day from three to four thousand people.

THE MECHANIC OF THE FUTURE, AND HIS TRAINING.

By Egbert P. Watson.

Mr. Watson deals with one of the most pressing problems of the day, so far as the mechanical industries are concerned. "There must be those who are shopmen exclusively; where are they to come from?" The answer proposed by such leading manufacturers as the Westinghouse and the Brown & Sharpe companies were described in our December and January numbers. The systems of the Allis-Chalmers and the Baldwin Locomotive works will follow. Mr. Watson treats the subject on its general merits, from the viewpoint of one long familiar with the practical aspects of the shop, and with relation especially to the scope and effect of the manual-training school.—The Editors.

FIFTY years ago a young man usually looked forward to a trade as his life work, relying upon a thorough knowledge of it for the means of subsistence. To obtain a chance to learn was comparatively easy, for the country needed skilled workers of all classes. It was only necessary for a parent to go to the principals of large shops, vouch for a youth's good character, that he had been to school, and that he wished to learn the trade, for him to be taken on at once as an apprentice. Afterward, his future depended upon himself. He was not bound by articles as in the older times, for employers had learned by costly experience that desirable boys kept their agreements to serve until they were twenty-one; those who were unreliable were not wanted upon any terms. If a boy showed a desire to learn, and was apt, he was rushed forward as fast as possible, and by the time he was of age he could be called capable in all branches of the business.

The young workmen at this stage were not recognized as skilled workmen, to whom any job, no matter how difficult, could be given; but they were fair, all-around men, who could be sent out of the shop to erect or repair work with confidence. They could chip and file details to drawings, and were particularly skillful with the last-mentioned tool. It is needless to say that they were always in demand at the wages paid in the United States at that period—$1.50 to $1.75 per day of ten hours. Thus it will be seen that out grandfathers put in from five to six of their best years to obtain merely a working knowledge of the handicrafts they had adopted. All that was expected of them was to be able to read drawings and interpret their mandates in wood or metal. They were not asked to show diplomas or parchments with degrees attached before they could get jobs; indeed, it was rather against them than otherwise to be suspected of scholarly accomplishments. What they knew, they knew; a good mechanic in embryo was not metamorphosed into a poor scholar, with a smattering of science and a superficial knowledge of mechanics and machines, to get his living as best he could with such an inadequate kit.

Men like those described blazed a trail through an almost pathless industrial wilderness. They built engines and boilers that did not work to their satisfaction; so soon as they saw the result of their labor, they built other engines which did work. Later on, they improved these until they had reached the confines of their possibilities as mechanics, and then they looked into the theory of things. Here they encountered difficulties at the outset; they were well trained in the solution of problems they could see and handle—tangible things which bound, and jammed, and stuck fast in their grooves, so to call them, because they were too tight, or too slack, or what not. These matters could be aligned and made accountable; but imponderable bodies, inert and unweighable, were an affliction. They were groping in the dark in common with others, for investigators of physics were scarce.

Seeing the field which was open for cultivation, men of experience in the various sciences gave the steam engine special investigation, and there are groups of observers in all civilized countries of the world at work upon it. Armed and equipped with instruments devised for the purpose, and backed by the prestige and support of universities, they have succeeded, aided by designers of steam engines, in diminishing the consumption of fuel to one-fifth of what it was a half-century ago, with a corresponding increase of efficiency. One set of observers supplements the other. The trained observers and the actual workers are of one mind, one accord certainly, in their intents. Technological institutes abound, and the labors of the constructors are lightened by their instrumentality. Some go even further than imparting a knowledge of theory, and combine practice with tools and workshop manipulation. To this last much more weight has been given than its importance warrants—in my opinion. Manual-training schools, so called, where students devote themselves to dexterity chiefly, in the several handicrafts, have their limitations also. At best they are preparatory schools for mechanics of the future, before they enter upon the occupations of their lives. Of the two institutions, the commercial shop and the manual-training school, the former is the best if lasting benefit is to be considered.

Not long ago I visited one of the most important technological institutes in the United States with the object of seeing exactly what the course was. A professor accompanied me through the shops, wherein the students were attending machine tools after a certain fashion—the fashion which is called "sojering" in commercial shops. That is to say, in a dilatory and uncertain way they were watching lathes nibbling off iron from a casting made for the purpose, a mere "waster" without shape or form, and good for nothing for any purpose.

"What is this young man supposed to be doing?" I asked the professor.

"He is learning the manipulation of a lathe; how to cut iron to the best advantage; to dress, to grind, and to set his tools; and the best speeds to run at."

"At at this particular moment what he is he doing?"

"He seems to be taking a finishing cut," said the professor.

"A finishing cut for what; is he fitting the piece to another casting or only to a certain size?"

"Only to size," said the professor.

"Then he might speed the lathe two steps higher, with advantage," I replied.

"The instructor does not think so," was the answer; " it would burn the tool."

"It might and might not," said I, "but if it did that is just what the young man needs to know—the possible and impossible speeds in turning various kinds of cast iron."

The professor said nothing, and we moved on to other departments where the same vague and general practice was noticed. The latter was not the best, and this I ventured to say to the professor.

"What does it lack?" he inquired.

"The tools are not of the proper shape, and they are ground badly."

"Will you show us how they should be dressed and ground?" said the professor.

"Willingly," was the reply, and taking up a so-called diamond-point turning-tool it was demonstrated that, as then made, it did not cut the metal but rather grubbed it off; by giving the tool side rake and front rake angles were formed which cut on both the rotary motion of the shaft and the lateral advance of the tool, the result being that the surface left was not only noticeably cleaner and smoother to the eye; but, what is far more important, the cylinder was truer—that is, rounder. There were other defects in the centres of the work, but as I did not care to pose further as a demonstrator I made no remarks.

As we passed along to the professor's office he said: "I can see the difference between our work and commercial work, in that in the latter every man is a demonstrator, and one expert man raises the character of all the others; we have only one expert to teach the students, and as he is so they are."

"Quite true," I responded, "but there is a more vital issue than the one mentioned, which is that there is no incentive for students to do their best or to find the quickest way of doing work. That is what they are supposed to be doing while at college. I believe you do not claim to make expert mechanics by your courses, but rather to familiarize your men by examples in machine work, and personal participation in it, so that later in life, when they are in charge of contracts, they may be able to detect good from bad work, and to estimate closely upon costs. How can they do that with the very slight experience they have had? Five years is usually required of young men in commercial workshops to learn the rudiments of their business, and they are occupied on all sorts of jobs for ten hours a day. Even at the end of their novitiates, their employers would not consider them capable of estimating upon the cost of work, or fitted to criticise it except superficially. It takes years of experience upon the profit and loss sides before men can do this satisfactorily, to avoid losses. I said previously that there was no incentive in your institution for students to put forth their best efforts, and that means there is no competition. When a man's bread and butter and that of his family depends upon his ability to turn out good work in a reasonable time, he endeavors to do his best, to the end that when the evil days come he will be chosen and kept on while single men are left to shift for themselves."

"You must acknowledge, though, that our graduates are in such demand that they can obtain situations at once," said the professor. "If the courses they pursue here are futile, why should manufacturers seek for them?"

"I do acknowledge it, for I know it to be the fact, and nothing that has been said during our cursory conversation is intended to mean that I am opposed to technical education on the broadest lines. Having been brought up, mechanically, in a shop, with only a boarding-school education to start in life on, at a little over fourteen years of age, I know full well the advantages of a technical education, and the difficulties of acquiring one by self-tuition out of working hours. I have had my nose held hard on the grindstone, in this respect, and envy the youth who has an opportunity to be taught the fundamental *principles* of his work. Apprentices of fifty years ago had no such chances. There were no text books even, except a few which were far beyond our comprehension, and we had to rely chiefly upon natural philosophies for what little we could gain from them. In this direction the benefits to be derived from technical colleges are incalculable, and I sometimes wonder whether the students appreciate them fully. I am candid, though, when I say that the shop courses, in so far as I comprehend their aim, are not precisely time wasted, but misapplied. You try to do too much in too short a time. The number of graduates turned out annually from technical colleges is very large; enough inchoate superintending engineers and managers are supplied to run two such nations as ours for some time to come, but where is the mechanic of the future to come from? He is needed now but he is not to be had. In every shop where there is plenty of work the crying need is for capable, all around mechanics."

I am well aware of many firms who, in so far as their own wants are concerned, are educating young men in the principles of machine work, to the end that they may have a reliable staff in stock, so to speak, at all times; but, in the nature of things, this source of supply to the industries of the country at large is inadequate. Moreover, I am not of the opinion that the average young man can drop one thing and take up a wholly different train of ideas with advantage to any one. Brain work and muscle work are unlike in their sequences; the same nerve forces are not on watch. True, one supplements the other to a great extent, and the union of headwork and handwork at the proper times is of benefit, but they cannot be exercised indiscriminately.

It is perhaps uncomplimentary to say this, but hewers of wood and drawers of water are more needed in the work of the world at present than men who are half scholars and half mechanics. A young man who is educated is not contented to stay in a shop a lifetime; he is trying to go up higher; but there must be those who are shop-men exclusively; where are they to come from?

Even the alleged specialists, men who hire out to do one thing only, or shape one piece, are lost in doubt when called upon to do a different detail with the same machine. It is the day of the handy man, who, when all is said and done, is only a first-class laborer. Too much automatic machinery in all trades has put the old time versatile mechanic out of business. Look at the carpenter's trade! It is no longer necessary for him to plough out mouldings, and house "trim" generally. Mills supply such details at a tithe of the expense, and of uniform quality throughout. Sashes and blinds, doors, winding-stair treads, transoms, everything required in a house almost, is delivered at the carpenter shop ready to hang. The same is true of boiler making. Details of all kinds that formerly had to be hand-made can be purchased in open market.

With the advent of hydraulic flanging, the most difficult and critical work the boiler maker had to execute by hand is now delivered as per blue-print furnished, exactly to dimension. All this is of benefit to everyone except the man who has to sell manual dexterity and a knowledge of the limitations of his trade. Not long ago a well-dressed man of, possibly, sixty-five, applied at the office of a celebrated engine works for permission to enter the shops. Visitors were not allowed, as a rule, but the manager, seeing as he supposed only a harmless, inquisitive old gentleman, waived the precept for the moment and passed him in. After an hour or so he was about to leave, with thanks, when the manager asked him, pleasantly, what he had seen.

"I saw," said the visitor; "several things; for one, a man putting tin 'shims' under the guide-bars of a high-speed engine to bring them to line. I saw another man trying to straighten a lot of studs with hot nuts that had been put into holes that were tapped crooked. I saw another man at work upon what he supposed was scraping a plane surface, when he wasn't. I saw nuts screwed onto bolts that they did not fit, so loose that the nuts could be twirled down with the fingers."

The manager was appalled. "You seem to have seen a good deal in a very short time," he said, rather irritably.

"Yes," said the old gentleman, "I did, and I wasn't looking for it either; it was there to be seen; I might have discovered other lapses from mechanical rectitude if I had more time and an inclination to peer into things."

"Who are you?" said the manager peremptorily.

"No one in particular," said the old gentleman; "only a man who served his time a half-century ago and still has a hankering for the shop and all its works; you have a splendid outfit of machine tools and a handy place, but you need a few more conscientious men," and out he went.

"Mr. Professor," I said, "the moral of this does not need a paver's ram to force it into recognition. A man who has not done the same things that he saw perpetrated in the engine shop would not have seen them, or, if he had, would have supposed they were a part of the regular procedure; shims are a venial sin to most persons on machine work, but on high-speed engines, where everything is supposed to be iron and iron, of rigor, they are unpardonable offences. Let me ask, without prejudice, if a student-graduate would have noticed the lapses named?"

"I am free to say that he doubtless would not," was the reply.

"Well, then," said I, "that is my case; I rest here," and with thanks for his courtesy generally, I went out.

Quite recently Professor Hannover, of the Royal Polytechnic, and director of the government testing laboratory, Copenhagen, made a tour through the principal British technical colleges with a view to examining the systems prevailing. His report is extremely interesting to all connected with such subjects, and seems wholly free from bias or prejudices of any sort. Some of his observations may be quoted here, as bearing directly upon the tenor of this article. Also, as might have been expected, it is a strong and well balanced plea for the need of technical education all over the world. I quote only the gist of Professor Hannover's report, not his exact words:—

> The Glasgow University agrees with our Copenhagen Polytechnic, inasmuch as it considers it necessary to acquire workshop practice in real workshops in order to accustom students to deal with time, money, and men. Mr. Goodman, of the Victoria University, objects to teaching workshop practice at all in the college instead of in commercial shops, and the consensus of opinion among British technological institutes generally is to the same effect.

Singularly enough, however, Professor Hannover states that English manufacturers have a great antipathy to graduates of scientific schools and will give practical men the preference in all cases. This would seem discouraging to a large class in England who feel that trade and commerce languish for want of better educated workmen, and a commission is now in the United States, with Mr. Alfred Moseley at its head, to observe the American public schools and see how far the system will apply in Great Britain. Professor Hannover says that in his visits he was struck by the fact that so few of the leading men had received a scientific training. Most of them were practical men who were undoubtedly clever, but having had no other advantages than those derived from the shop and the night school, were fitted only to go on in the old ruts and never to strike out on new lines.

Be this as it may in England, there is need of practical men, by whom is meant those who intend to follow certain trades of their own choice as a means of livelihood, in every part of the United States. With the ban placed by trades unions upon the number of apprentices employers are permitted to engage, it is not wonderful that mechanics are scarce and likely to be scarcer in time to come. Richter (Johann Paul Friedrich) said two centuries ago:

> "Every man has two educations—that which is given him, and the other that which he gives himself. Of the two kinds the latter is by far the most valuable. Indeed, all that is most worthy in a man he must work out for himself. It is that that constitutes our real and best nourishment. What we are merely taught seldom nourishes the mind like that which we teach ourselves."

All of which seems to apply favorably to the old ways of making mechanics.

There are still young men in the United States who desire to learn trades as a means of gaining livelihoods, but they are of a different class from the boys of half a century ago. They are not graduates from high schools, but the sons of laborers, in a majority of cases, who, knowing the benefit of a trade to a young man, and seeing the high wages the skilled workman receives in comparison with men of no trade, endeavor to get them into shops. They enter as apprentices and sign printed forms to serve four years. The first year they receive 50 cents per day, and the last year $1.25 per day, and are then rated as journeymen, free to go where they please. No education of any kind is given them; if they desire to study theory, however, they must do so of their own volition from sources outside of the works. These young men fill a certain demand only; if there were more of them it would be better, but the country grows faster than the supply of shopmen; hence the scarcity.

According to the aptitude of individuals these men are good, bad, and indifferent mechanics, or workmen, but they have acquired a certain position and facility with the routine of commercial shop work, and they fit in somewhere.

It seems to me that an experience of this nature would be much better for young men who have aspirations for professional situations in life than the systems in vogue generally in technological institutes. Candidates for scholarships in them will not be received unless they have had certain preparatory courses in study, prior to their applications, in specific lines; but no stipulations are made as to mechanical ability of any kind, and a regular kindergarten in rudimentary machine work (if I may so call it without disrespect) is established for all who desire to take it. There does not seem to be any reason why scientific colleges should be at the expense of this, particularly when it is of so doubtful value in the scientific course, and of no value at all from a commercial aspect, as I have tried to show in preceding lines. A young man should come prepared in the rudiments of every branch he takes up, machine work included, and in my opinion college machine shops should be abandoned wholly, in the interests of both parties, the students and the faculty. If a young man puts in four years in a commercial shop, during that time he has opportunities for self-examination as to whether he really wishes to follow the profession of a mechanical engineer, or had misconceptions of it. He gets a knowledge of men and methods which he cannot obtain in the college shop, and has a clearer perspective of his future. On the other hand, he may become so interested in the practical side of machine work as to decide against a scientific course, in which event he becomes a desirable shopman. From an economic standpoint he might do worse. Professions are not mines of wealth; those who have embraced them are not paid in proportion to their merits, anomalous as it may seem. Men have grown gray in the services of colleges without receiving more than a very small salary. Be this as it may, the shopman has by no means a poor outlook in comparison with many of the so-called learned professions—lawyers, physicians, and even clergymen. He can command now $3 per day, and much more if he is a skilled man; on piece and contract work he can make "good money," as the saying is. Few professional men make $3 per day in the early years of their careers, and there is nothing in the calling of any workman to debar him from civic or national honors if he seeks them. The only thing which prevents more young American men from taking up trades is the fancied stigma which attaches to a mechanic, so-called, among a certain class—one, by the way, whose verdict is of no importance from any aspect.

If I had a life to live over I should devote five years to learning a trade first. I would go into a shop without giving any one a hint as to my intentions later, and would take what came, keeping an open eye and receptive mind for all within my field of vision. After such an experience I would go to a scientific school (if not outlawed by an age limit) and absorb knowledge as a sponge does water. As one benefit from this course, I would have a sound mind in a sound body, enabling me to study hard and to appreciate more readily the teachings of science. I could see exactly where it agreed or conflicted with practice.

If I may say so without offence, I have but little faith in certain educational fads which resemble the bed of Procrustes. Those who sought entertainment upon it were cut off if too long and stretched if too short, with, doubtless, disastrous results. Certain courses are to be given at certain times in class, the student-workman dropping his task meanwhile and readjusting his mental faculties to another gauge. It may be that this is feasible, and that some individuals can assimilate what is offered, but as a system it is open to objection. Mr. Josh Billings, holding hilarious and shrewd views of life, said that it was better to know a few things that were correct than so many that were not so, and this applies to professional careers. If a man has a solid foundation under him which he has built up himself with a hammer and chisel, so to speak, he can get at least bread as a workman, when other lines fail.

EDITORIAL COMMENT

THE Panama policy of the Senate minority is a puzzle to the layman. It is not wholly clear to the practical mind how "political capital" can be made by opposing and delaying the Administration in a measure which is so widely popular—so impatiently demanded—as the definite beginning of work on the Isthmian Canal.

To that honest but partly-informed sentiment, however, which can not get beyond a fancied wrong to Colombia, and therefore halts and hesitates to deal with the supposedly guilty State of Panama, we offer the following intimate view of the Panameños before the recent revolution. It is by a distinguished and loyal Colombian, Señor A. Galofre, and appeared in a Bogotá newspaper—*El Relator*—the translation being from a copy which has just reached us. It has therefore a weight which might not belong to any statement coming from Isthmian sources. Spain's treatment of the Cubans, which we held a cause and justification of our armed intervention, was no worse than Colombia's treatment of the Panameños as set forth in Señor Galofre's arraignment of his own country:—

"From owners and lords of the soil, we have converted them into outcasts in their native land. Roughly and unexpectedly we took from them their rights and we suppressed all their liberties. We deprived them of the most precious faculty of a free people—that of electing its governors, its legislators, and its judges. We restricted their suffrage; we falsified the election returns, and we caused the wish of a mercenary army, and a train of government employees, foreign completely to the interests of the department, to prevail over the popular wishes. We took from them the right to legislate, and as compensation we placed them under the iron yoke of exceptional laws. The State, provinces and municipalities lost completely the autonomy they formerly enjoyed. We limited their taxes and their right to employ them. In the really cosmopolitan cities of the Isthmus we have not founded national schools where their children could learn our religion, our language, our history, and the love of our country. Before all the world we have punished their writers with imprisonment, banishment, fines, and the lash, for the innocent expression of opinion. From December, 1844, to October, 1903, presidents, governors, secretaries, prosecuting attorneys, mayors, aldermen, military heads, officers and soldiers, chiefs, inspectors, and adjutants of police, the police itself, captains and port surgeons, magistrates, judges of different categories, comptrollers—all came from the highlands of the Andes or from other parts of the Republic to impose upon the Isthmus the wish, the law, or the whim of the strongest; to traffic in justice, or to speculate with the public funds; and that train of employees, like an octopus with many tentacles, sucked the sweat and the blood of an oppressed people and devoured that to which in fact only the Panameños had the right.

"We turned the Isthmus into a military barracks. And when this people of 350,000 souls produced men of continental reputation such as Justo Arosemena, notabilities of the first order and of almost irresistible popularity like Pablo Arosemena and Gil Colunje, men of talent and learning like Ardila, accomplished diplomats like Hurtado, and men celebrated in science and with European reputation like Sosa, we pushed them aside, relegating them to disrespect and forgetfulness rather than giving them positions of influence in the Isthmus. Such proceedings wounded the pride, the dignity, and the patriotism of all intelligent men of the Isthmus, and fomented and provoked the odium and the hate of the mass of the people.

"We now feel the result of all these errors. The last twenty years have been very bitter and cruel for the Panameños, and they will not wish in the future to be Colombians if they must continue to live under a regimen which does not permit them to be citizens in their own country."

Señor Galofre concludes with the significant exclamation:—"Either Federal government for Panama, or dissolution!" Can anyone believe Bogotá would have granted the Federal government, or that, apart from the exasperation of the rejection of the Hay-Henan Treaty, dissolution would long have been delayed?

* * *

WE HAVE reviewed elsewhere in this issue the valuable comparison made by Professor Cathcart upon the relative merits of water-tube and cylindrical boilers for naval service, and closely upon that study comes the news of the disaster upon H. M. S. Wallaroo, in which four stokers were killed and three seriously injured as the result of an explosion of a cylindrical marine boiler. This event demands comment at this time especially because many of the opponents of water-tube boilers have enlarged upon the fact that a boiler of that type may be disabled in consequence of the bursting of a single tube. That a Scotch boiler is liable to such an explosion as occurred off the coast of New South Wales does not seem to have occurred to its advocates, and fortunately indeed such accidents are rare; but with water-tube boilers they are impossible.

When properly constructed, the shell of a cylindrical boiler is amply strong to resist the internal pressure which it is called upon to bear, while the improved corrugated and suspension furnaces have shown themselves far superior to the older forms, if proper care is taken to prevent accumulation of grease or deposit. There is always a weak place, however, in the Scotch boiler, this being the combustion chamber at the rear of the furnaces, connecting these latter with the tubes. This portion is necessarily of irregular shape and must depend for its strength upon staying, while it bears externally the full pressure of the steam. According to the reports of the explosion on the Wallaroo the stays on top of the combustion chamber gave way, resulting in a collapse, followed by the discharge of the entire contents of the boiler into the stokehold.

By this demonstration of the possibilities of such disasters the case of the water-tube boiler is materially strengthened at this time, and the influence of the accident will doubtless be great. The work of the stoker is most difficult at all times, and with the ever impending possibility of a fearful death before him the task has added severity. Ultimately it is to be hoped that mechanical contrivances will replace human effort in this heavy work, but in the meantime the continued use of boilers which may and do explode should be limited, and the far safer sectional steam generators should be installed.

REVIEW OF
THE ENGINEERING PRESS.
"THE WORLD IS ITS FIELD"

COMMERCE AND ENGINEERING.

THE RELATION OF THE COMMERCIAL DEVELOPMENT OF THE WORLD TO THE SCIENTIFIC DISCOVERIES OF THE NINETEENTH CENTURY.

Marcel Bichon—Revue Générale des Sciences.

IN all ages the growth of the commerce of a nation has been taken as the index of its prosperity, and at all times it has been the effort of progressive governments to foster and aid in commercial development. It was not until the beginning of the nineteenth century, however, that the influence of applied science upon manufactures and commerce began to be seriously felt, while at the close of that century engineering may well be claimed as the controlling factor in commercial progress. A general review of the evolution of the commerce of the world and its relations to the scientific discoveries of the nineteenth century is given in an interesting article by M. Marcel Bichon in a recent issue of the Revue Générale des Sciences, and the relation between commerce and engineering is there very clearly shown.

At the time of the Congress of Vienna, in 1815, upon the restoration of peace after the Napoleonic wars, the markets of the world were controlled by four nations: Great Britain, France, the Netherlands and Spain. These had all conducted their operations upon the antiquated methods which had prevailed from mediæval times, but from thence a new spirit began to prevail. In England the development of internal manufactures, following closely upon the introduction of steam power, the spinning frame, the power loom and the rolling mill, led to the adoption of free trade, admitting the food stuffs which the land was no longer able fully to supply, and permitting the march of industrial development *to proceed unhampered.* Although the rest of the world did not adopt the same system, yet throughout all manufacturing nations the influence of machinery began to be of controlling importance.

Following closely upon the development of power manufacturing came the locomotive in 1829; while preceding it, the work of Fulton led to the practical development of steam navigation as an element in the transformation of commerce. The Savannah crossed the Atlantic in 1819, while in 1825 the Enterprise made the first steam voyage to India. The engineer had established his grasp upon the commerce of the century by the time one-fourth of its years had passed. Screw propulsion soon followed the paddle wheel, and by the middle of the century great lines of steam navigation connected all parts of the world.

In the meantime the growth of railways had proceeded with increasing rapidity, and by the joint facilities thus given to commerce by the engineer the markets of the whole world were thrown open to the manufacturing nations of Europe.

With all this growth of commerce and manufacturing a new mode of communicating intelligence became necessary, and the task of providing it devolved upon the physicists. The result was the electric telegraph, originated in the United States by Morse, in England by Wheatstone, and developed in France by Bréguet. Hardly had overland telegraphy been practically introduced than submarine communication was attempted, and in 1851 the cable across the

Channel was laid and the telegraph line between Paris and London opened. Submarine cables then rapidly multiplied, and after the reverses of 1858 and 1865 transatlantic communication was finally opened in 1866, as a crowning result of the commercial energy of Cyrus W. Field and the scientific genius of Lord Kelvin, then William Thomson.

Transportation both by land and by water having thus been given to commerce by the engineer, as well as instantaneous communication overland and under sea, a new task was undertaken. The piercing of the isthmus of Suez was planned to bring the Orient 5,000 kilometres nearer to Europe, and in 1869 the Aigle passed from the Mediterranean to the Red Sea, and the engineer had opened a new route to commerce.

In the meantime these developments had met with a hearty response from the commercial world. Great engineering enterprises demand great financial resources, and the growth of banking facilities and aggregations of capital kept pace with the progress of industry. The discovery of gold in California and Australia came as stimulating additions to the wealth of the world. In 1846 the production of the precious metals is estimated at 310 millions of francs per year; in 1851 it had grown to 686 millions.

The greater proportion of all this development fell to England and France, and this momentous fact was revealed to the world by the series of international expositions which have done so much to aid in commercial development. In 1851 there were 17,000 exhibitors; 24,000 took part in Paris in 1855; at London, in 1862, there were 27,500 exhibitors; while at Paris in 1867 the number reached 42,217.

The growth of British commerce during the successive periods under consideration will show the extent to which the causes already cited affected it. In 1811 the external commerce of Great Britain was estimated at 1,400 millions of francs; from 1855 to 1859 it averaged 7,800 millions; and from 1865 to 1869 the average was 13 milliards. A parallel development took place in France. Thus from 1845 to 1850 the yearly average was 2,225 millions, while in 1865 to 1869 this had risen to 7,935 millions.

In all this progress Germany had taken *little or no* part, but after the events of 1870-71 the formation of the German Empire caused a new competitor to enter the field of commerce and of applied science. In spite of the great lead which had been attained by the older nations, Germany showed herself prompt and ready to profit by all the elements of commercial success which had been so effectively developed, and soon the mark "made in Germany" appeared in the markets of the world wherever manufactured goods penetrated.

Again a new and still more formidable candidate for commercial and manufacturing supremacy apeared upon the field. Before the Civil War the United States had been fully occupied in developing its own vast territory, but after the last traces of that conflict had disappeared a new order of things began. From 1877 to 1895 the great republic of the western world was actively building up her industrial resources, and then she vigorously entered upon a campaign of world commerce, which has given her a strong place among the great controlling nations.

Thus at the close of the nineteenth century the commercial control of the world stood transformed from the conditions which existed one hundred years before. Four great nations again held the commerce of the world between them, but the four were no longer the same, and Europe furnished but three of them. England, Germany, France and the United States—these constitute the great sources of the world's supply, followed at a distance by Belgium, Holland, Russia, Italy, and all the minor train.

The engineer of the past century has worked this transformation; the engineer of to-day is continuing the work with increased efficiency and vigor. It is more than probable that no great inventions or wonder-working discoveries will immediately appear; rather will the work take the form of improvement, extension, consolidation. Railway speeds and capacities will be increased, steamships will grow as harbours are provided to receive them. Methods and processes will be improved in character and enormously increased in efficiency; wastes will disappear from manufactures; labor will be handled and rewarded scientifically, effectively and adequately by the engineer.

If the past can ever be accepted as any

uide for the conduct of the future, the leson of the nineteenth century may well be tudied by the nations which are struggling or supremacy in the twentieth. The work f the engineer transformed the commerce, the politics, the finance, and the very life of the century which has just gone. What he may do for the present century depends wholly upon the opportunities which are given to him.

SCREW-PROPULSION FOR WARSHIPS.

A DISCUSSION OF THE IMPORTANCE OF THE SCREW PROPELLER AS A WEAPON OF OFFENSIVE WARFARE.

Royal United Service Institution.

In the merchant marine the screw propeller is regarded merely as a means for propelling the vessel from one place to another, but in the naval service it is often called upon to perform another function, that of driving the ship against the enemy, as in ramming or otherwise inflicting injury. Considering the propeller, therefore as a weapon of offensive warfare Fleet Engineer Quick presented a very interesting paper before a recent meeting of the Royal United Service Institution.

Examining first the possibilities in speed improvement by making proper improvements in the propellers, Mr. Quick cited the case of recent occurrence in the Royal Navy:

"The maximum speed of the four great cruisers of the Drake class was just over 23 knots with their original propellers. Without doubt the various makers of those propellers considered they were the very best propellers that could be designed for those vessels, and as those vessels attained something over the speed for which they were designed, the results appeared quite satisfactory. But the Admiralty very wisely ordered new blades of 30 per cent. greater area to be made for the Drake, with the result that the high speed of 24.11 knots was attained with practically the same indicated horse-power as had been required for 23.05 knots. If the original screws had been retained, they would have required 41,000 indicated horse-power to drive the ship at the speed of 24.11 knots. Please to consider the increase in weight and space, and cost of the boilers and engines of 30 per cent. greater power than the present boilers and engines, and also the increased consumption of fuel to provide that increased power. You would easily see that it would be almose impossible to cram such powerful engines and boilers into those ships, unless the store-rooms and magazines were abolished and the ship converted into a mere steaming machine.

"The enormous value of the Admiralty improvement of the Drake's screw must be apparent to all. But this improvement having been effected, the question arises: Is it possible to make a further improvement in the propellers of those ships so as to drive them at still higher speeds with the same horse-power? Experiments alone on one of those vessels can show exactly how much the maximum speed of those ships can be increased, but by some considerable changes in the present form of the screw propellers there is every probability of an increase of speed of at least one knot being attained with the same maximum horse-power—or, in other words, that the speed of the Drake class can be increased to 25 knots with the present boilers and engines, and with practically the same coal consumption as at present. To effect this, the proposed new screws would have to be more efficient than the large screws of the Drake to the extent of 4800 indicated horse-power. And as the large screws of the Drake gave a speed equivalent to an increase of 10,500 indicated horse-power over the original small screws, 25 knots is not an extravagant estimate for the speed of the Drake with propellers still further improved in design."

An important question in connection with possible improvements in screw propellers is found in the determination of the rate of increase in resistance with increased speed. If, as some maintain, the resistance increases as the fifth, seventh, or even tenth power of speed, there is indeed small hope for improvement. Such [illegible] however, are based upon small in tanks, and upon the rapid dicated power of ships at their higher speeds.

It is the opinion of Mr. Quick, based not only upon his own experiments but also upon the investigations of Mr. Robert Mansel, that it is not the resistance of the ship, that increases as the seventh to the tenth power of the speed at the highest speeds, but that it is the efficiency of the screw propellers which falls off at the higher speeds, and thus a very large part of the engine power is uselessly expended. It is far more probable that the resistance increases only as the cube of the speed, and that to attain higher speeds it should be the aim to reduce the rotational resistance of the propellers. In order to investigate the propeller losses at high rotative speeds Mr. Quick examines the case of a propeller of infinite pitch, in which all the energy is expended in overcoming rotational resistance, compared with a similar case for successive working pitch ratios showing very clearly that the rotational resistance increases much more rapidly than the propelling effect as the rotative speeds are increased.

"It has required many years of scientific research and hundreds of trials to bring the ordinary radial-surfaced screw, with its narrow-pointed blades, to its present condition of efficiency, and it is therefore to be hoped that a series of trials will be given to those new designs which appear to promise a large increase to the maximum speed of our warships and greater economy at all speeds, as modern conditions of great power and high speed of revolution demand changes in the dimensions, proportions, and form of the screw propellers to suit the new conditions.

"The adoption of four-bladed screws in lieu of three-bladed screws for our warships will be found of the greatest advantage in actual war. Accidents to propeller blades occur even during peace; and in war injuries to them will be much more frequent. When one blade of a three-bladed screw is broken off or seriously damaged, the remaining two blades will, if that screw be used for propelling, throw a very heavy stress on the shafting and cause excessive vibration, while the speed of the ship will be very small. But if one blade of a four-bladed screw be broken, and the engines be worked, there will be less strain on the shaft, less vibration, and a higher speed may be attained. This point is of importance to those who may have to command ships of fleets in battle.

"Twenty-eight years ago the writer advocated a combination of independent screw and hydraulic propellers; the latter being available for pumping vast quantities of water from the ship in case of ramming or injury by torpedoes. In consequence of the loss of the Victoria, and the recent ramming of the Prince George, it appears desirable that additional pumping power should be supplied to our fighting ships. That pumping power could be arranged to discharge the water astern, so as to be a considerable auxiliary propeller in case of injury to the screw engines and to the screw propellers. But the primary object of the large pumping power is to keep the ship afloat, for it is believed that in the naval battles of the future the ships will be so injured after an hour's plucky fighting that many ships will be sunk if they have only the present amount of pumping power; but that side which can keep the largest number of vessels afloat and capable of moving, if only at eight-knot speed, will be able to compel the enemy to surrender and thus to hold command of the sea against that particular foe."

It is interesting to note the revival of interest which is appearing in the subject of hydraulic propulsion, and reference may be made to the paper of Mr. Rankin Kennedy, reviewed elsewhere in this issue. In the course of the discussion upon his paper Mr. Quick gave some additional data upon the subject which are of general interest in the same connection:

"Great improvements have been made in the power and efficiency of pumping engines and pumps since the Waterwitch was built in 1866, and the Thornycroft hydraulic torpedo boat in 1883. At the present time Greenwood and Batley, of Leeds, are making the De Laval steam turbine engines and pumps combined up to 300 horse-power. These weigh about nine tons, and occupy a space of about 18 cubic yards only. A pair of 600 horse-power De Laval engines and pumps would weigh about 36 tons, and occupy 72 cubic yards. These engines of 1,200 total horse-power would be able to pump about 17,000 tons of water per hour from a ship, *i. e.*, about as much water per hour as our biggest battleships displace. It is therefore evident that these pumps could cope successfully with an enormous amount of damage to the hull from ramming or torpedoes, which damage, with our existing appliances only, would certainly sink the ship.

"The water would be discharged in equal quantities astern on each side of the stern post, so that in the event of partial or total disablement of the screw propellers the jets would propel the ship ahead at a moderate speed, and in case of injury to the rudder the ship would be steered to a certain extent by the propelling jets. Of course, if the ship was uninjured, and the screw engines were disabled, the turbine pumps would take their suction direct from the sea. It is a matter for the consideration of naval commanding officers whether the proposed additional pumping, propelling, and steering power would be in actual battle worth a few hundred pounds in cash, the occupation of 72 cubic yards of space in the ship, and the substitution of 36 tons of machinery for 56 tons of coal."

GAS-POWER FOR CENTRAL STATIONS.

THE ADVANTAGES OF OPERATING ELECTRIC GENERATING STATIONS IN CONNECTION WITH GAS WORKS.

J. R. Bibbins—American Institute of Electrical Engineers.

SEVERAL years ago the late Sir Frederick Bramwell made the prediction that by the year 1931 the steam engine would be of interest only as a relic of a past age, having been entirely superseded by the various forms of internal-combustion motor. When it is remembered that he said this at the meeting of the British Association, in 1881, when the gas engine was built in small sizes only, and considered by steam-engine designers as little more than a toy, the wisdom of the prophecy will be more apparent. To-day, with engines of 1,000 horse power and more in daily use, and with interest and activity in the subject daily growing, it takes no especial foresight to see that, for many purposes at least, the internal combustion motor is the coming engine. An interesting contribution to the subject is the paper recently presented before the American Institute of Electrical Engineers by Mr. J. R. Bibbins, discussing the advantages of operating electric stations in connection with gas works, the electric generators being driven by gas engines, and the gas works supplying the fuel.

It will be remembered that when electric lighting was first introduced it was supposed to be a great rival to existing gas companies and gas stocks took a tumble. Experience has shown, however, that there is room for both, and in *many places the gas and electric stations are operated by the* same company. Mr. Bibbins gives data from a number of installations in which this idea is carried still further, the electric station being made a partial customer for the gas plant, to the extent of using gas as the source of power from which to generate the electric current. The general proposition which he maintains is that present gas-power machinery is suitable for central-station service; that the economy is far better than a steam plant; and that the most effective way for a gas works to meet electric competition is to install a gas-power electric-generating station, and become its own largest customer, selling both gas and electricity at competitive rates.

Probably one of the principal reasons for hesitation of the engineer in considering gas power for an electric station lies in the question of irregularity of operation, but according to the investigations of Mr. Bibbins, the records in existing plants for continuous running compare favorably with those of steam-power plants.

The majority of the plants are operated from 18 to 22 hours per day, and in some instances the engines are run continually from Monday morning to Saturday night without stopping.

"In cost, the gas-engine equipment is quite comparable with that of a steam plant. The engine itself costs more than a steam-engine of corresponding size, on account of the increase in metal required by the higher pressures dealt with. With the cost of condensing machinery charged to the steam-engine, however, this disparity is much reduced. With natural or illuminating-gas supply available, the equipment-cost would fall considerably below that of a steam equipment of boilers, engines, condensers, heaters, pumps, etc. In the case of a producer-gas plant installed to supply the gas-engines, the cost of the respective equipments, each of 1,000-h. p. is at a parity, although depending somewhat upon the storage capacity provided."

The economy of the gas engine in fuel is well understood, even small gas engines giving a superior thermal efficiency than is attainable with the largest steam engines. The fuel cost of a horse-power naturally depends to a certain degree upon the nature and cost of the fuel, but in general the fuel consumption should not exceed 1 pound per brake horse-power-hour.

Apart from the immediate fuel economy, however, the gas engine possesses other advantages which conduce to general station economy. The efficiency under light load is higher than that of a steam engine of corresponding size. The cost of operation and maintenance is low, largely because of the simplification of the equipment and the small number of auxiliaries. The engine can be started much more quickly than is possible with a steam plant, and the absence of high pressures except in the engine cylinder removes all danger of explosion. The ability to store power in the form of gas in a holder is a valuable feature of a gas power plant, the cost of power storage in this way being far less than when electric storage batteries are used.

"An important source of economy in gas plants is the fact that as soon as an engine is shut down all heat-losses cease. Also, during operation no heat is lost by the gas in transit from the producer, and the plant is not hampered by inefficient auxiliaries such as steam-pumps, condensers, return-traps, etc., all of which largely increase the general complexity of the system. Steam-pipe and cylinder-condensation losses, radiation, leakage in piping, and fuel-loss in banking fires, have no parallel in the gas plant. The only auxiliaries required are the igniter-generators and air-compressors. The former are negligible as affecting the economy of the station, and the latter operate at full capacity at regular intervals. In cases where artesian wells supply jacket-water, a pump is of course, required, preferably operated by a motor or small gas-engine to which the air compressor may also be belted.

"In quick starting, the gas-engine fulfils every requirement. The 280-h. p. pumping units of the Philadelphia high-pressure fire system have been repeatedly started cold, brought up to speed and the pumps loaded to the required pressure (300 lb. per sq. in.) within a period of 40 seconds from the starting signal. In another plant, employing 133-cycle high-speed generators, the units are regularly started in two minutes, and this may be reduced to one minute in case of necessity.

"A number of plants make use of hot jacket-water for heating offices and building, ordinary cast-iron or coil-pipe-radiators being used for this purpose. One station partly supplies a municipal heating system resembling the Yaryan, thereby deriving direct revenue from a waste product. Part of the return-water is sent again through the jackets, the temperature being lowered to the proper degree by adding fresh water from the station supply-main. Another station returns hot jacket-water to a large cistern where it partially cools and is again pumped through the jackets emerging at a temperature of 200 degrees F. before being discharged into the sewer. As return water from a heating system is also discharged into this will, a small amount of cold water from artesian well or city water system is added from time to time, to reduce the general temperature of the circulating system. In another plant, the jacket-water is utilized in winter for warming the water in the gas holders to prevent freezing. This was formerly done by using live steam from a boiler used in making water-gas."

Various kinds of fuel gas may be used in internal-combustion engines, and the relative economy of different gases is sometimes considered as depending upon the calorific value. As a matter of fact the different gases require different proportions of air to be used to make the proper explosive mixture, and the ratings are better made by comparing the calorific value per cubic foot of the actual mixture delivered into the cylinder. Under such conditions the value of various gases is nearly uniform, as will be seen by the accompanying table, the only ones falling much below the average being producer and blast-furnace gases.

	Approximate B. T. U. per cu. ft.	
	Gas	Mixture
1. Natural-Gas	1000	91.0
2. Coal-Gas	650	91.7
3. Water-Gas	300	88.0
4. Carburetted Water-Gas	600	92.0
5. Producer-Gas	120 to 145	60 to 68
6. Coke-oven gas	600	90.0
7. Blast-furnace gas	90	53.0

"The power to be developed by an engine of given proportions does not therefore vary within appreciable limits, except on producer-gas and blast-furnace gases, when larger engines are required, or larger cylinders on the same engine frames. The rate of combustion is, however, less rapid with these than with other gases, due to the large amount of inert gases such as nitrogen and carbonic acid present in the mixture. The compression may also be carried much higher without risk of pre-ignition or "back-firing," thus increasing the efficiency of the cycle. With water-gas the high percentage of hydrogen occasions quicker combustion and higher flame temperatures with so considerable a tendency to pre-ignition and back-firing that this gas is not well adapted to gas-engine work.

"In water-gas plants a great saving may be made and the gas rendered much more suitable for the operation of gas-engines by providing additional holders for the air or blast-gas made during the period when the producers are under blast. This gas is equivalent in calorific value to blast-furnace gas—90 B.T.U.—and is generally allowed to go to waste. It may however be used to great advantage for power purposes, either alone or mixed with a proportion of water-gas which it renders less snappy and thereby better suited for use in gas engines. In fact, by this means a gas is obtained similar in many respects to the producer-gases made by operating a producer continuously with combined steam- and air-blasts.

"Leaving out of consideration the by-product, or waste coke-oven and blast-furnace gases, as occupying a field of power development somewhat foreign to the subject in hand, producer-gas offers at present the greatest possibilities in the field of power for use in manufacturing centers. This is due to its comparative cheapness, simplicity of installation and general efficiency when gas for power purposes is alone considered."

Mr. Bibbins includes in his paper tabulated data and results of a number of gas-power stations and has reduced the results of his investigations to curves for which the reader must be referred to the original paper. The conclusions are so generally favorable to the commercial advantages of the combination of gas works and electric generating stations that the arrangement must appeal with much force to the managers of existing gas plants who are seeking to extend their business, and the whole subject is an excellent example of the manner in which new and improved methods and systems act, not as injurious rivals to older plants, but as reasons for extended scope and efficiency.

THE TEMPERATURE OF FLAMES.

RECENT DETERMINATIONS OF THE TEMPERATURES OF VARIOUS FLAMES BY THE USE OF THE SPECTROSCOPE.

Ch. Féry—Académie Des Sciences.

THE determination of the actual temperature of a given flame is a matter which presents certain difficulties, and hence the presentation of a paper before the French Academy upon an accurate method, together with the results of a number of experiments, demands notice. M. Ch. Féry, whose paper is given in a recent issue of *Comptes Rendus,* discusses the usual methods of temperature determination and shows the reasons for variation.

The ordinary method for measuring the

temperature of a flame is to insert into the flame a small solid body, which body it is assumed, must acquire the temperature of the flame itself. If this body is the junction of a thermo-electric couple, it may itself be used as the means for measuring the required temperature. Results obtained by this method, however, are very discordant, showing the existence of various defects in the method, even after all apparent corrections have been made. Among the sources of error we may include the losses by radiation, of which the corrections are uncertain, also the emissive power of the metal, which, at high temperatures is imperfectly known, especially since it may be modified by the action of the gases upon the physical constitution of the surface. It is certainly known that carboniferous flames affect the purity of platinum, and change its conductivity, an important matter in connection with the use of thermo-electric couples.

The presence of a foreign body may alter the temperature for certain other reasons, among which may be noted the effect upon the velocity of the gaseous current. The burning gas possesses a certain degree of viscosity, and the presence of a solid body, however small, alters the velocity of the gaseous layers which surround it. Since the specific heat of a gas is very small compared with that of a solid, and because gases are much poorer conductors of heat than solids, certain phenomena observed in this connection will be seen to have an influence upon the determination of temperatures. Thus, a platinum wire of 0.02 mm. diameter in readily fused in the flame of an ordinary Bunsen burner, but the resulting bead remains unaltered and solid in the same flame, although the temperature is unchanged. This shows that the retardation of the flow of the gases caused by the bead prevents the temperature from exceeding 1,780° C., so that a platinum thermo-electric couple is unequal to the determination of the temperature of the flame of a Bunsen burner.

The method employed by M. Féry avoids the introduction of any solid substance whatever in the flame, being based upon an entirely different principle. This principle is that of the reversal of a given line of the spectrum by means of the rays emitted by a solid body raised to a convenient temperature. At the moment when the line of the spectrum, in passing from light to darkness, disappears, the temperature of the solid corresponds to the temperature of the flame.

In the practical experiments conducted by M. Féry the solid substance selected was the filament of an incandescent electric lamp, the temperature of which could be readily determined by the use of the absorption pyrometer, the rays emitted by the solid incandescent carbon traversing the flame to be examined, this latter containing the vapor of sodium. By use of a lens an image of the filament was obtained in the slit of the spectroscope in such a manner that the continuous spectrum given by the incandescent carbon was seen traversed by the D-line, so that it could be reversed, and consequently made to disappear by any of the flames under investigation.

M. Féry gives a number of determinations of flame temperatures, and as these represent the latest accurate measurements of values of practical use we give some of the more important ones. Thus for the Bunsen burner, burning ordinary illuminating gas, the mean of 8 determinations, the burner having a full supply of air, gave a temperature of 1,871 degrees Centigrade, while with a half supply of air the temperature fell to 1,812 degrees, and the total suppression of the air supply brought down to 1,712 degrees. The acetylene flame gave a temperature of 2,584 degrees, and a free alcohol flame showed 1,705 degrees. By taking a Denayrouze burner, intended to be used with an incandescent mantle, and using the vapor of alcohol, a temperature of 1,812 degrees was attained, or nearly the same as with the Bunsen burner, showing that in this case the mantle should give about the same amount of light as with the corresponding incandescent gas burner. The same lamp, using a mixture of alcohol carburetted with 50 per cent. of benzine, gave a temperature of 2,053 degrees, this being decidedly higher than the 1,900 degrees obtained with a flame of hydrogen burning freely in air.

With the gas blowpipe, using oxygen and illuminating gas, a temperature of 2,200 degrees was reached, while the oxy-hydrogen blowpipe, burning the gases in the proportion required to form water, attained a temperature of 2,420 degrees. The oxy-acetylene blowpipe, reference to which has already been made in these columns, gives a still higher temperature, estimated to be about 4,000 degrees C., but this has as yet not been verified by the method of M. Féry.

The importance of these scientific determinations of flame temperatures must be admitted, especially as they show the influence of the presence of solid bodies in cooling flames locally. Not only does this cooling affect temperature determinations by the earlier methods, but the same action exists when flames are used to heat solid bodies. For this reason it is important that gas furnaces and similar appliances should be arranged with heat absorbing substances, so disposed as to store up the heat and provide a sufficient mass of incandescent material to offset the absorption of the cold material inserted in the flame. Experience has shown the advantages of such constructions to practical work, and the laboratory tests of M. Féry confirm the soundness of the method. Thus a simple block of fire brick, suspended over a gas flame absorbs heat which it again radiates downward upon a solid substance placed in the flame, and while such a simple addition cannot raise the actual temperature it does prevent the lowering of the heat which would otherwise occur. Similar arrangements are made in many practical cases, and with the increasing of the clean and convenient gas furnace this feature will doubtless be given scientific study and improvement. In the meantime the determinations of M. Féry will doubtless stand as the most accurate and reliable measurements of flame temperatures which have yet been made.

SMOKE PREVENTION.

PRACTICAL METHODS IN USE FOR PREVENTING THE FORMATION OF SMOKE IN STEAM-BOILER FURNACES.

W. H. Bryan—Purdue University.

In an address recently delivered before the students of Purdue University, Mr. W. H. Bryan discussed the methods in practical use in the West and Southwest for the prevention of smoke from boiler furnaces, and in view of the extended experience which he has had in this important subject some abstract of his remarks are here given.

Smoke is mainly due to the presence of volatile matter in the coal, and as the Western fuels are rich in volatile matter the smoke problem has assumed especial importance in cities in which these coals are used.

"When a fuel rich in volatile matter is charged into a furnace, the volatile matter is first set free as a gas, principally in the shape of hydrocarbons. Part of these are of the olefiant series, and are dissociated at a red heat. Part of the carbon is set free, and if unconsumed, it passes off as smoke. It is possible to burn this free carbon, if sufficient oxygen is present, and the temperature is high. Failing in either of *these conditions, there will be smoke.*

"The free carbon in the densest smoke is very small—from one-sixth to one-half of 1 per cent. by weight. It has, however, great coloring power. You may stamp as false all claims of fuel saving due to consuming the smoke. The best furnaces, however, do make savings in fuel, not because they burn the smoke, but because improved construction and better engineering details bring about more favorable furnace conditions. The saving is often more than sufficient to pay a good interest on their cost, besides repairs and maintenance."

Mr. Bryan gives three methods of preventing smoke. The first of these is the heroic one of shutting down the smoke-producing establishments. In many instances, however, this has been the best of all methods, because it has compelled the offenders to use electric power derived from some central station. An excellent example of the relief by this drastic method was seen in New York when the smoke-producing locomotives were removed from the elevated railroad system, the fuel-combustion being concentrated at the power houses where it could be taken care of. Ultimately this will be the true solution, the burning of smoke-producing fuels being altogether prohibited within city limits and proper methods of prevention required at the generating stations where the current is produced for municipal use.

The next best plan is the use of smokeless fuels. This cannot be expected to be generally adopted so long as the cost of such fuels continues to be far higher than those which ordinarily produce smoke. Anthracite, coke, or oil may be burned without producing smoke, but in most markets the smokeless fuels are out of reach in cost. Possibly the use of oil in motors of high economy, such as the Diesel, may help to solve the problem, but when burned under boilers, oil costs too much to compete with the cheaper coals.

Passing to the smoke producing fuels, Mr. Bryan describes the various methods which have been employed to promote smokeless combustion. When a boiler is ample in size for its work, so that it may be fired slowly and quietly the matter is a comparatively simple one.

"A good ordinary boiler furnace without a special device can be so handled as to greatly reduce the smoke, providing, of course, it is not overworked. It is not necessary, therefore, to buy a patent furnace. Nor will the installation of improved apparatus of itself control the smoke. A deep furnace, high bridge wall, ample grate surface and good draft are essential to a good smoke record. Such a furnace, skilfully fired, will make no serious smoke when working up to, say, two-thirds of its rated capacity. By skilful firing is meant the charging of alternate doors with small and uniform quantities of fuel, particularly if the coking system of firing is used. The firing of consecutive doors, at long intervals, with large quantities of fuel, and by the sprinkling method, is responsible for a very large proportion of our smoke. If the furnace, however, is not well designed, or is overworked, no amount of skill or care will keep the smoke within bounds. In such cases resort must be had to special apparatus."

Among the successful processes Mr. Bryan names five which are to be considered. The first of these is the use of steam jets, either below or above the grate. These naturally act to produce induced currents of air and to drive these currents into the fire, thus providing an excess of oxygen and aiding in the necessary mixing of the air and gases. Properly arranged they will reduce the smoke, but they are not usually economical of fuel, and to give the best results they should be given some attention.

A better system, and a far older one, dating back to the time of Watt, is the use of coking furnaces, or their modifications in the form of fire brick arches. These are based upon the principle of keeping the fuel well away from the chilling action of the boiler surfaces and completing the combustion at a high temperature in the presence of the proper quantity of air. They require additional space and should be given intelligent attention, two requirements which it appears difficult to obtain.

Another appliance is the down-draft furnace, which in many instances has given very good results. Two grates are used, the upper one forming part of the circulating system of the boiler, the grate being made of water-tubes to resist the high temperature. The second grate is beneath and the gases from the two grates meet between them, where thorough combustion is effected. Mr. Bryan gives as the principal objection to this type its high first cost and its connection as a part of the circulating system of the boiler.

An important class is that of automatic stokers, in which Mr. Bryan includes chain grates and underfeed devices.

"These have come into extensive use, particularly in large modern plants. While they are built in many forms, they all operate on the same principle—that of feeding the coal automatically to the grates in continuous and regular amounts. Most of them are designed for the use of the finer grades of coal, such as nut, pea or slack. In many localities there is a surplus of this fuel, and its cost is low, but the increased demand is raising the price and reducing the supply. Many recent stoker plants are provided with crushers to permit the use of the larger sizes of coal when necessary. When accompanied by coal handling and storage plants, the automatic stoker reduces the labor required in the fireroom, and this arrangement has been adopted in

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bjections to automatic stokers are:
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The fuel to be burned should
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kind is selected, as they are not
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Powdered fuels have also been considered as enabling complete and smokeless combustion to be maintained, but down to the present time the cost of grinding to the fine degree necessary for the best results has been prohibitory.

A plan not mentioned by Mr. Bryan, but which may yet be found to meet all requirements is the general employment of gas fuel. The leanest and poorest of coals may be used under proper conditions for the production of fuel gas, and when employed in connection with internal-combustion engines a high efficiency can be attained together with the entire abolition of boiler and furnace. The ideal system would include gas-power electric generating stations, delivering electric power into all parts of a city, and wholly replacing smoke producing furnaces of any kind.

THE NORTHERNMOST RAILWAY OF THE EARTH.

ING OF RAILWAY COMMUNICATION BETWEEN THE GREAT IRON ORE DEPOSITS OF LAPLAND AND THE SEA.

H. Claus—Glasers Annalen.

RAL years ago the importance
magnitude of the deposits of iron
in the northern part of Sweden
vay were described in the pages of
azine, and the interesting paper by
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ch some abstract is here made.

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f about 60° N. The present road
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h the Atlantic ocean, and passing
through the great iron-ore deposits of Gellivara, Kürunavara and Luossovara. These ores are especially adapted for use with the basic process, containing an average of 65 per cent. of iron, and from 1 to 2 per cent. of phosphorous. Deposits also exist containing as high as 68 per cent. of iron, and sufficiently low in phosphorous to be suitable for the acid Bessemer process. The total area of the deposits covers about 425,000 square metres and the quantity of ore available above the level of lake Luossajärvi is estimated by the Swedish State Geologist, Professor Lundbohm, as from 233 to 292 million metric tons. If the excavations are continued below the level of the lake the amount of ore which can be taken out is estimated at 500 to 750 million tons, and more.

Various plans have been made in past years to provide railway access to these important ore deposits, and as long ago as 1870 an English company obtained certain concessions. Later these plans were undertaken by a Swedish and Norwegian private company, but the work met with various difficulties and only the Swedish from Lulea to Gellivara was completed. Finally, owing to the international character of the work, it was decided that it should be completed and controlled by the government. The arrangements were concluded in 1898 and the work, as has already been stated, was brought to a successful conclusion last summer.

The terminal of the railway on the Atlantic is at an excellent harbor at Narvik, this being 174 kilometres distant from the nearest ore beds at Kürunavara and 286 kilometres from Gellivara. The total distance from Navik, on Ofoten Fiord to Lulea on the Gulf of Bothmia, is 483 kilometres, or 300 miles.

Apart from the importance of the opening to commerce of these important deposits of iron ore the connection of the northern section of Norway and Sweden to the railway systems of Europe is a matter for comment. At Boden, not far from Lulea, the new railway intersects the Swedish railway system, extending southward on the one hand to Stockholm and the rest of the peninsula, and on the other to St. Petersburg and the whole network of Russian railways. From Navik to St. Petersburg, a distance of 1,800 kilometres, there is now continuous railway communication, and from St. Petersburg on over the line of the Siberian Railway to Vladivostok. By the completion of this railway the line across Europe and Asia connecting by rail the Atlantic and the Pacific oceans is achieved, the distance being 11,900 kilometres, or about 7,400 miles, and at the average speed of 30 kilometres per hour the journey from ocean to ocean may be made in about 16 days.

THE PREPARATION OF BOILER FEED WATER.

AN INQUIRY INTO THE WORKING OF VARIOUS PROCESSES FOR SOFTENING WATER FOR USE IN STEAM BOILERS.

Institution of Mechanical Engineers.

So long as steam boilers are in use, so long will efforts be made to prevent the formation of scale or to get rid of it after it has been formed. Many plans include the putting of things into boilers to keep the impurities from doing any harm; while still other, and more reasonable plans have been advocated to prevent the injurious matter from getting into the boiler at all. This whole question of the preparation of boiler feed water forms the subject of an important paper presented before the Institution of Mechanical Engineers by Mr. C. E. Stromeyer and Mr. W. B. Baron, which we take this occasion to review.

In the first place an important distinction is made between the action of scale upon the heat efficiency of a boiler and upon its durability.

"It has frequently been stated that scale seriously reduces the heat efficiency of boilers, and experiments have been made which seem to prove this assertion, but it will be found that they have been carried out on wrong lines, and they only prove that scale very seriously interferes with the transmission of heat *if* the heat source, usually a flame, *is* of equal temperature over the whole surface. In a boiler the temperatures vary from 3,000° to 4,000° F. at the furnace, down to 500° to 1,000° F., where the gases leave the boiler. Let us take a simple case, assuming for convenience of calculation that the heat transmission from flame to boiler-plate is proportional to the difference of temperatures. Let the ratio of air to fuel be as 20 to 1; let the air temperature be 80° F., then the flame-temperature will be 3,000° F. If the steam-temperature is 380° F., the maximum temperature of the furnace-plates will, in the above example, be only 20° F. higher than that of the steam, viz., 400° F. Now let us assume that the heating surface is covered with scale ⅛ inch thick; then, if the same quantity of heat were transmitted through the coated furnace-plates as through the clean ones, the temperature difference between one side of the scale and the fire side of the furnace would be 350° F., and the temperature of the plate would be 730° F. It is, however, clear that as the boiler-plate is hotter than in the first example, less heat will be transmitted to it and the temperature gradient in the scale will be less steep. Naturally also the flame will not get cooled so rapidly, and its temperature, as it reaches the next portion of heating-surface, will be higher than before."

Tabulating the results of an investigation into the temperature distribution in a boiler, assuming first entire freedom from scale, and secondly, a layer of scale ⅛ inch thick, it is shown that even for fairly high differences of temperature, such as occur for the portions in which the ratio is ¼ square foot of heating surface per pound of fuel per hour the reduction in the heat transmission is only 11.6 per cent., while by the time the gases reach the end of a lightly worked boiler, where the ratio is 4 square feet per pound of fuel per hour, the total reduction in transmission is only 2.5 per cent. When boilers are subjected to hard firing or forced draft the difference is of course greater.

The great injury caused by scale is that of the effects of overheating upon the plates. Even ⅛ inch of wet scale may raise the temperature of the furnace plates by nearly 300° F.

"Scale is thus a serious danger, and, as is well known, has frequently caused accidents. It will be noticed that in clean boilers the temperature of the furnace-plate is nearly the same as that of the water, whereas in the scaly boiler the excess temperature is about one-tenth of that of the flame. If, therefore, in the first case we open the furnace door and admit cold air, the excess temperature of the furnace-plate can at most be reduced 20° F., causing a contraction of only 1-90 inch in 8 feet, whereas cold air admitted to the furnace of the scaly boiler will effect a rapid reduction of about 311° F. accompanied by a contraction of 1-6 inch in 8 feet, which is a very serious matter. In fact, in a rigid structure these two strains would be accompanied by stresses of 1:5 and 22 tons respectively. Boilers are elastic, but a large fraction of these stresses certainly make their appearance every time that a furnace door is opened, say once every half-hour, or 6,000 times a year. No wonder, therefore, that in high-pressure boilers, which are necessarily more rigid than low-pressure ones, this constant straining leads to grooving at the furnace flanges. With scale ¼ inch thick the stresses would be nearly doubled.

"We thus see that scale does not materially reduce *the efficiency of a boiler, but it* seriously increases its wear and tear, whereby its life is considerably reduced. It also endangers the safety of boilers. The same remarks apply to coatings of grease due to feeding the boiler with water containing condensed steam from the engine. It is, therefore, desirable to remove all scale-forming impurities from the feed-water. These impurities are suspended matter, carbonate of lime, sulphate of lime, magnesium salts and grease. One has also to be on one's guard against introducing large quantities of soluble salts, as these concentrate when the water evaporates, until thick scales of crystals are formed."

Mr. Stromeyer examines the behaviour of the various impurities in feed water at length, and his paper forms a valuable essay upon this important subject. The chief cause of temporary hardness is the presence of carbonate of lime, which, being converted into bicarbonate of lime, is readily soluble in cold water, and is of very general occurrence. So-called permanent hardness is caused by sulphate of lime, while the salts of magnesia are also objectionable. The presence of grease in a boiler is more injurious than any scale, and much of the trouble from overheated plates is due to the presence of a film of grease, carried into the boiler with the feed water from the condensers. It is impossible here to go into the whole subject of feed water purification, but a brief summary is here given:

"Carbonate of lime forms hard scale in economisers and a soft mud in boilers, unless sulphate of lime is present, when it also is cemented into a scale. Carbonate of lime can be removed by boiling or by adding enough caustic lime or caustic soda to combine with the free and half-bound carbonic acid which hold it in solution.

"Sulphate of lime forms no scale in economiser pipes, but it forms a very hard scale in boilers and also cements the carbonate of lime deposits. Its deposition in boilers is due to slow concentration of the water, and it is, therefore, desirable to remove the salt entirely. This can always be done by adding carbonate of soda which converts it into carbonate of lime.

"Carbonate of magnesia generally behaves like carbonate of lime, except that it is slightly more soluble.

"The other salts of magnesia are very soluble. They seem to cause corrosion and should be removed. This can be done by treating them like the sulphate of lime by adding carbonate of soda.

"Grease should, if possible, be kept out of a boiler. Neither separators nor filters will remove it entirely from feed-waters, but this can be done by mixing them with impure waters and treating them in water softeners."

The theory of water softening has been well known for a long time, but there are various practical difficulties which only appear in the actual working of the apparatus. Thus carbonate of lime, when precipitated by proper chemicals, is in a colloidal condition, like thin starch, and passes readily through the best chemical filters. The fineness of the precipitate renders it very slow in settling, especially when cold, so that very large tanks and much time are required. By carrying out the softening operation hot the separation is more readily effected, and smaller tanks may be used. Magnesia precipitates are also very difficult to manage, because of their gelatinous nature, and heat is usually found necessary in their treatment.

Another important practical matter in water treatment is that of properly apportioning the chemicals. The class of labour to which this work is often intrusted is found lacking in judgment; the apparatus should provide some mechanical means of regulating the amount of material added and its proper admixture. In many cases too little lime is added, and an excess of soda is applied, while when heat is employed it is not given sufficient time to effect the best results. No process can be expected to give entire satisfaction without a certain amount of skilled supervision, but the benefits to be gained by proper treatment are well worth the cost of such oversight.

The paper is accompanied with illustrated description of a number of the best devices for water softening, and forms a valuable contribution to the literature of the subject.

STROBOGRAPHIC METHODS OF OBSERVATION.

THE SLOW REGISTRATION AND INVESTIGATION OF PHENOMENA OF HIGH RAPIDITY OF OCCURRENCE.

E. Hospitalier—Institution of Electrical Engineers.

NEARLY two years ago we reviewed in these columns a paper presented before the French Society of Civil Engineers upon modern methods and devices for observing rapidly varying periodical occurrences. We now have a later paper upon a similar subject, presented before the Institution of Electrical Engineers, in which M. Hospitalier, to whom the original paper was due, discusses especially the progress which has been made in strobographic methods for examining moving objects. The paper is an excellent example of the manner in which indirect methods may often be found more useful than direct methods of apparently similar character.

"Indirect observation, based upon stroboscopic principles, is effected by reproducing the phenomenon with a much longer period, obtaining the record of the whole of its phases by taking them successively from a large number of periods. The period of oscillation peculiar to the apparatus may, in this case, be very long as compared with that of the phenomenon observed, provided that the duration of the total number of periods from which the different phases are collected is itself very great relatively to that of the oscillation peculiar to the recording instrument.

"Notwithstanding the elegance of the direct methods, and the results which have already been attained with instruments based upon them, the author is of opinion that the industrial future is reserved to the indirect methods, which have a wider field of application, and which permit of the direct recording of the phenomenon to be studied upon a strip of paper, in a way that is not possible with the direct methods, in which recourse is always had to photography. In order to understand the principles of the stroboscope, as applied to the observation and recording of periodic and rapidly-varying phenomena, the most simple of all the periodic movements may be considered—namely, that of uniform rotation.

At the end of every revolution the rotating system attains the same relative position that is occupied one complete turn earlier. Suppose, now, that the system is illuminated for a very brief instant once in each revolution at the moment at which it passes a certain position, which is regarded as the initial position. The rotating system will then appear at rest. If, now, the periodic illumination be slightly retarded, so that the successive flashes follow one another at an interval of time a little longer than the period of the revolution itself, the system will be illuminated in its various phases in turn, and will appear to revolve slowly in the sense of its actual rotation. If, on the contrary, the flashes follow at shorter intervals, the system will appear to be turning in a sense inverse to that of its real rotation, since at every revolution it will be illuminated an instant before it attains the same position as on the preceding revolution. In this way the apparent velocity of rotation will have been reduced in a proportion which depends only on the acceleration or retardation of the successive illuminations of the system.

"The simplest means of obtaining these successive flashes consists in using a disc pierced with a slit as a shutter in front of a projector. The same result may be obtained by means of the sparks caused by interrupting the current through an inductance, or with alternate-current arcs, &c., but the sharpest effects are obtained with the revolving stroboscopic disc.

"In order to obtain a variable difference in the periods or slip, it is possible to use an electric motor of which the speed is capable of variation—or a synchronous motor if the system is driven by a synchronous machine—which determines the measure of the slip, or a train of wheels as in the ondograph, or (the most rational of all) a differential gearing of which one of the axes is controlled by the system to be studied, whilst the other actuates the stroboscopic disc and the crown containing the intermediate wheels between them receives from an outside source a more or less rapid movement of rotation which defines the slip. This disposition offers the great advantage of allowing the phenomenon to be apparently stopped *in any specially interesting position.*"

All such methods, in which the phenomena are simply observed by the eye as they occur, are of value in connection with the study of any special apparatus, being really similar in principle and operation to the well-known zoetrope. It is most desirable, however, that phenomena under observation should be recorded automatically and independently of the observer, in order that the personal equation may be wholly eliminated. Such instruments are called strobographs, this term being broadly applied to all forms of apparatus employed to record phenomena, whether rapidly or slowly variable, if they utilise the principle of the stroboscope.

H. Hospitalier describes a variety of instruments which come under this definition of a strobograph, the principal being the ondograph, or wave recorder, used for registering directly such electrical phenomena as the curves of variable currents, differences of potential, power, etc. The detailed construction of the apparatus is fully described in the paper, the principle being the use of a rotating drum and a revolving commutator, both being driven by a synchronous motor, the relative rotative speed-relation being capable of variation through a train of gearing. By the use of a suitable recording measuring apparatus, varying in character according to the nature of the phenomena under observation, all the conditions obtaining in the visual stroboscope are reproduced mechanically.

The applications of the ondograph are numerous, and M. Hospitalier gives examples of some of its records. Thus it is understood that the curve produced by an alternator is in principle a sine curve, as free as possible from the higher harmonics, but the records actually obtained show that this is far from the case in practice.

Some of the curves obtained in the instrument show the influence of the shape of the pole pieces, which introduce the third and fifth harmonics, while others exhibit the effects of the teeth. A careful study of the curves makes it possible so to alter either the pole-pieces or the number or shape of the teeth that the objectionable distortions are greatly reduced, and hence the instrument possesses an immediate practical value. Other important applications are found in the investigation of the reaction of the alternating current on the excitation, and in a study of the variation in the difference of potential between the terminals of a rotary converter. Various interesting applications, of which M. Hospitalier gives the recorded diagrams, are seen in the variations occurring in the primary current of a transformer for given variations in the secondary and again in the study of the action of the electrolytic rectifier. Many other applications of the instrument are apparent, such as the study of the Wehnelt interrupter, the continuous-current arc, rectifiers, the oscillatory charge and discharge of condensers, polyphase currents, the simultaneous record of potential differences, current, and power in an alternating circuit, etc.

A large portion of the improvement in the efficiency of the steam engine has been due to the study of the operation of existing machines by the aid of the indicator, and it is certain that many improvements would have been long delayed had not some such mechanical method of recording internal action been employed. The employment of strobographic methods permits similar investigations to be made of electrical action in a manner not otherwise possible, and many improvements in structural and operative details should follow their use.

MODERN NAVAL BOILERS.

A CRITICAL COMPARISON OF THE RESPECTIVE MERITS OF WATER TUBE AND CYLINDRICAL BOILERS FOR NAVAL USE.

W. L. Cathcart—American Society of Naval Engineers.

ALTHOUGH the relative merits of the water-tube and cylindrical types of boilers for naval use have been and still are subjects of active discussion the progress which has been made in the installation of the former kind has been marked in the last year or two. A very excellent review of the present situation appears in the Journal of the American Society of Naval Engineers, by Professor W. L. Cathcart, and in view of the present importance of the subject some abstract of the paper is appropriate.

Mr. Cathcart reviews rapidly the entrance of the water-tube boiler into the marine service, referring to the early installations of the Belleville boiler in the French navy as long ago as 1856, and the successful career of the Martin boiler in the American navy. The advent of the mutiple-expansion engine and the continual increase in steam pressures, however, led to the general use of the cylindrical, or Scotch boiler, both in the merchant marine and in the naval service, and it was not until 1885 that any serious attempt was made in England to use any other type. The first installations were of the small-tube type in vessels of moderate size; Thornycroft boilers being fitted to torpedo boats and destroyers. The extending use of the improved Belleville boiler in France led to the decision in 1893 to equip the cruisers Powerful and Terrible, each of 25,000 horse-power, with the Belleville boiler, while in the United States the Ward boilers were fitted to the monitor Monterey in 1892.

"From 1888 onward, the progress of the water-tube boiler has been swift. In torpedo craft it has long since vanquished its cylindrical competitor, and the change is complete, since the requirement in these boats of very high speed with small displacement has forced the development of the greatest possible boiler power on the least possible allowances for weight and space, while the locomotive boiler—the immediate predecessor of the water-tube in this service—was not only relatively heavy, but, under the necessary limitations as to weight and space, required an air pressure sometimes reaching 8 inches, to develop the power required."

In the United States navy the cylindrical boiler is still in use in the older vessels, but its day in that field has passed. The last battleships thus equipped were those of the Wisconsin class, contracted for in 1896, and all subsequent installations have been of the water-tube type.

Mr. Cathcart reviews the action of the Boiler Committee of the Admiralty, and ex-

ecommendation for the com-
both types for the present in
ry.
, which has been tried, and,
essels abandoned by both the
and Germany, will probably
and temporary in Great Brit-
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installations have greater
eam pressure, and some diffi-
ation. These disadavantages,
ly advance of the water-tube
tle the question. As a whole,
that the cylindrical boiler is,
at least, practically excluded
t vessels of the world's navies,
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omprise but 20 per cent. of the
quired in each combination."

ctory service which is given
boiler in the merchant marine
as an argument for its reten-
vessels. In the case of mer-
the steaming is continuous
nd the boiler passes from one
r, is cleaned and repaired, and
e its return run. The naval
ether different in its character
nts. A boiler may be pressed
capacity one day, and lie idle
uccession. Under such condi-
drical boiler has not given the
at has been obtained in con-
d these facts should be borne
making the comparison.

value of the water-tube boil-
ought out by considering its
r successive heads, these in-
apidity of raising steam, the
ler strong forced draft, rapid-
ction and repair, weight sav-
danger from explosion. In
sentially military qualities the
ler is deficient, as numerous
. In addition the water-tube
ses greater flexibility of the
reater ease of cleaning water
he possibility of higher steam

ons which have been urged
ter-tube boiler have not been
. Thus the charge that they
nical in continuous service is
nited information about non-
cases. More recent trials have given results wholly favorable to the water-tube type, and with increased experience there is every reason to believe that the water-tube boiler will prove the more economical under all conditions. It has been maintained that there is a constant necessity for fresh feed water for the water-tube boiler, and that the increased weight of evaporators counterbalanced the gain in boiler weight. An ample supply of fresh water should also be supplied to cylindrical boilers, and when this provision is made the difference disappears.

The principal objection to which any force is admitted is that of the disablement of the boiler by the bursting of a single tube. The repair in the case of the latest types of water-tube boilers, however, have been greatly facilitated, and improvements in this respect are constantly being made.

There is no doubt that the best results with the water-tube boiler are attained only with the exercise of greater skill and attention than have been given to the cylindrical boilers.

"Intelligent firing is a factor of much importance in the aggregate efficiency of an installation including water-tube boilers. The amount of water contained is small as compared with the extent of heating surface, making steam generation a sensitive action, while the grates are wide with two or more doors, giving a sea barbarian fine opportunities for checking combustion by a fire of hills and hollows and by the frequent inrush of cold air through doors open too often and too long. What is required is simply a fire of even and moderate depth throughout, with coal fed at regular intervals and in regular order through the various doors. Without system and a fair amount of intelligence and training in this, the efficiency of the boiler will be seriously impaired.

"It seems clear that the water-tube boiler, in some forms at least, has reached a stage of development which makes the use of the cylindrical type in war vessels a grave military error in the sacrifice of such advantages as rapidity in raising steam, forcing in emergency without detriment, swift construction and repair, and weight-saving which can be utilized in added speed, armor or armament. The cylindrical bo
has so blocked progress in these paths
its usefulness as a war instrument s

ended. As to the objections urged so often against the water-tube type with regard to complexity and sensitiveness in operation, it may be said that these conditions are relative only, and vary widely with different boilers. Even if this were not so, such objections cannot be considered as a bar to added military strength. Nelson's short and sightless smoothbores, with their excessive windage to allow for hot shot, were somewhat less complex and less difficult of operation than the massive rifles of to-day with their actuating mechanism. The leading boiler need of the present seems to be not so much further development as the thorough training of the fireroom force to meet the new conditions and to maintain the trial efficiency of the water-tube boiler in cruising duty."

FILTRATION AND TYPHOID.

REPORT OF DR. GEORGE A. SOPER UPON THE CAUSES OF THE EPIDEMIC OF TYPHOID FEVER AT BUTLER, PENNSYLVANIA.

Engineering News.

FORMERLY epidemics of diseases were considered as matters wholly for the consideration and efforts of the physician; to-day they fall largely within the scope of the work of the engineer. An epidemic of typhoid fever breaks out in a Pennsylvania town, and an engineer is sent by an engineering paper to present the causes and the methods of prevention before the engineering profession, and the whole affair is considered as an engineering question. The epidemic of typhoid fever in the town of Butler, Pennsylvania, has thus been made the subject of a special investigation by Dr. George A. Soper, and his report appears in a recent issue of *Engineering News,* by which paper he was sent to the place under consideration.

Apart from the immediate interest of the case under consideration, the matter possesses the broad aspect of representing the conditions of hundreds of other towns in various parts of the United States, in any one of which the conditions and results might be repeated at any time, and hence the report is of more than local interest and importance. The report of Dr. Soper gives the details of the situation at Butler very fully, and for these the reader is referred to the original document, but here we may give the general state of affairs, and show their bearing upon the whole subject.

Briefly, Butler is an excellent example of the prosperous American town, which while increasing in population and importance, has not outgrown petty village methods. The government resembles that of a city in form but remains that of a hamlet in fact, and the inevitable consequences follow sooner or later.

A waterworks is installed, and being under the general control of a company in a neighboring city which makes a business of such cases it is fairly well planned and operated. The supply is taken from a stream which flows through the town, but the intake is situated at a reasonably safe distance above, a reservoir being formed by a dam, and the water brought down to the pumping station through mains. Here mechanical filters, using a coagulant, are installed, so that a reasonably pure supply, fairly well filtered, has been delivered to the town, with the result of a good general health record, so far as can be ascertained. The village methods, however, include such an imperfect system of reports that the records are wholly worthless, as may well be seen from the fact that when 1,000 known cases of typhoid fever were under treatment by the physicians, but 42 had been reported.

Two things happened, however, and then trouble began. The first was the breakdown of the dam at the impounding reservoir above the town, and while the repairs were being made water was taken directly from the stream opposite the town, although numerous sources of pollution were plainly in evidence. The second event was the temporary stoppage of the use of the filtration plant, due to changes in pipe connections because of the installation of an additional pumping engine, so that for a short period the unfiltered water of the polluted stream was served out to the unsuspecting residents. Dr. Soper says: "Toward the close of October the filters were shut down to permit a connection to be made with a new pump. They remained out of service for a period of ten days. During these ten days the water was not filtered. It is practically certain that the germs which caused the epidemic entered the water supply in this interval." The filters were out of service from October 20 to October 31; the epidemic of typhoid fever broke out on November 2.

The connection between causes and results can hardly be more clearly set forth than by the above plain statement of facts. A fairly pure supply of water, reasonably well filtered was accompanied by general good health. Even when a polluted supply was substituted no bad results appeared so long as the filter plant was interposed between the contaminated water and the inhabitants. When, however, this last barrier was removed the disease immediately appeared. As if further to confirm the correctness of the deduction, it appears that in one section of the town comparative immunity from the disease existed, and upon investigation it was found that this section was not supplied with the polluted water, receiving water from artesian wells.

According to the report of Dr. Soper, the filter plant was not supposed to have a high bacterial efficiency, being intended to remove clay and other earthy impurities only, but it is evident that it did keep the fever germs out so long as it was in action, and hence that even an imperfect filter is far better than none. The filter plant consisted of six open gravity filters of 15 feet diameter and 8 feet depth, the filtering material being composed of 6 inches of gravel and 4½ feet of quartz sand, sulphate of alumina being employed as a coagulant. The increased demand for pure water, due to the rapid growth of the town, together with the effect of the present epidemic, will probably lead to the extension or improvement of this filtration plant, but, even such as it is, it has demonstrated most clearly the great value of filtration as a defence against the spread of disease in drinking water.

The lesson of Butler will doubtless be well remembered by the inhabitants of that town, but it would not require a long search to discover many other such places,where the conditions are ripe for an epidemic, and where some slight barrier, easily and unconsciously broken down or removed, may next release the germs of disease and death. Under present conditions nearly every availeble source of water supply is either already polluted or may become so without warning or indication. It will not do to depend upon any supposed pure source of supply, and no such chances should be taken. Proper purification is the only method of safety, and experience has demonstrated that filtration provides a satisfactory purification.

NON-REVERSIBLE MARINE ENGINES.

METHODS OF EMPLOYING NON-REVERSIBLE ENGINES TO ADVANTAGE IN CONNECTION WITH THE PROPULSION OF VESSELS.

Institution of Engineers and Shipbuilders in Scotland.

ONE of the developments which is accepted as certain to follow the improvements in the steam turbine and in internal-combustion motors is their application to marine propulsion; and, in fact, the first important installations of the Parsons turbine were on board the small high-speed vessels which have contributed so much to the fame of the motor. The practical difficulty with these motors, however, is found in the impracticability of reversing them with that promptness and certainty which is so important in manœuvring a vessel, and *hence it has generally been found* necessary to effect the reversal in some other portion of the mechanism of propulsion.

This subject is discussed in an interesting manner in a paper recently presented before the Institution of Engineers and Shipbuilders in Scotland by Mr. Rankin Kennedy, and published in the *Transactions* of the Institution, and we make some abstract of his treatment.

The steam turbine has been applied to a number of vessels, and the question of reversal has been met by the employment of an auxiliary turbine for backing, this being considered practicable in view of the fact that backing is generally performed at low speeds and for short periods of time. It is desirable, however, that the full motive power of a vessel shall be promptly available for propulsion in either direction, and unless the improved motors are able to do this with the same facility as now exists with the marine engine they remain at a manifest disadvantage.

Various methods are now in use for reversing the direction of propulsion without changing the direction of rotation of the engine. Those generally employed with small vessels involve some change in the action of the screw propeller, such as reversing the angle of the blades by means of a sliding rod through a hollow shaft, or by reversing the direction of its rotation by change gears and clutches. In some cases both right and left hand screws are used, one or the other being locked to the shaft by a clutch system.

For larger vessels such methods are inapplicable, as they do not permit of the necessary strength and stiffness in the important connections between the engines and the screw, and some other plan becomes necessary. Mr. Kennedy examines two methods, discussing their merits at length.

The first of these involves the use of electric transmission between the engine and the propeller. The engine drives a dynamo and the propeller is driven by an electric motor. When the propeller is to be reversed its motor is reversed, while the engine and dynamo continue in the original direction of rotation. In many ways this plan offers much to attract the engineer. The long and troublesome shaft connection between the engine and the propeller disappears, and but a moderate length of shafting is needed aft, including the thrust bearing. The speed of the engine remains uniform, and may be anything best adapted for efficiency and convenience. A small high-speed steam turbine may be used to run a suitable dynamo, while the motor is proportioned to the best speed for the screw. The machinery may be placed wherever convenience indicates while all the control can be centralized on the bridge, a feature of great value. This plan is available alike for steam turbines or for internal-combustion motors, and the only objections which may be urged against it are the losses in efficiency in the double conversion from mechanical to electrical energy and back again, and the limitations at present existing in the size and power of electric motors.

A second method suggested by Mr. Kennedy involves the use of hydraulic jet propulsion. This in itself may suffice at once to condemn it in the eyes of many engineers, but there is no reason why a properly designed jet system may not be employed to advantage. The screw propeller itself is nothing more than a large jet pump, and the difficulty with jet systems which have placed the pump on shipboard has invariably been that they used a jet of too small section and too high velocity.

"It may at once be admitted that the jet propeller has some well-defined limitations which will prevent it ever becoming a better propeller than a screw in large steam-driven ships employing reciprocating or other reversible engines. The column of water set in motion to produce the jet is limited in sectional area. In Ruthven's *Waterwitch*, built in 1867, the area of the jets combined was 6.28 square feet, equal to 1-53 of the midship section of the vessel, and the efficiency was 0.18. In Thornycroft's hydraulic vessel, built in 1883, the area of the jets combined was about 1 square foot, equal to 1-14 of the midship section, and the efficiency was 0.254. Efficiency depends to a large extent upon the sectional area of the jet being a very large fraction of the midship section.

"The presence of a large volume of water on board the vessel is the chief drawback to the jet propeller. But by good design this volume can be much reduced, for, although the water must leave the vessel at a slow velocity in a large volume, it may pass along inside the vessel at a high velocity in a smaller column."

The modern forms of centrifugal pumps, operating in series, and driven at very high rotative velocities by the steam turbine, enable high-velocity jets of water to be obtained with a small and light mechanism, and the use of such jets to induce large-volume, slow-moving jets for the actual propelling effect is entirely practicable. With such a device the reversing of the direction of the vessel is readily effected by reversing the discharge direction of the jet, the engine and pumps maintaining a continuous, unvarying direction of rotation.

Mr. Kennedy calls attention to the fact that certain internal combustion engines are reversible, citing especially the Bertheau three-cylinder oil engine. used by Thornycroft. The Diesel engine is also readily reversible, and has been applied with success for the propulsion of vessels in a manner altogether similar to the ordinary marine engine.

While the various methods discussed in the paper of Mr. Kennedy are of interest, they all depend upon the progress which may yet be made in the various forms of construction involved. The jet propeller is as yet not a success, although the reasons for this are well understood. Until now there has been no good reason for developing it in connection with existing reciprocating steam engines, but if its perfection is essential for the full application of the steam turbine to marine propulsion. it will undoubtedly be so perfected. The electrical method involves the construction of large and powerful motors, adapted for the onerous conditions of marine service, but there is little doubt that such motors could be promptly produced upon demand, while with an efficiency of 90 per cent. each for generator and motor a joint efficiency of more than 80 per cent. would be available, and it is not at all certain that this is lower than is now attained with long shafts supported on flexible hulls in rough weather.

PRACTICAL ADVANTAGES OF SUPERHEATING.

THE BENEFITS OF SUPERHEATING AS APPLIED TO EXISTING STEAM ENGINES OF IMPERFECT DESIGN.

M. Delaporte—Revue de Mécanique.

It is one thing to discuss an engineering problem from the fundamental principles and to be able to apply those principles in apparatus of entirely new design, but it is altogether a different matter to assume that a complete theoretical analysis can be applied to existing installations, designed and constructed according to methods and ideas of an entirely different kind. It is undoubtedly for this reason that contradictory results are obtained in many instances in which it is attempted to apply scientific principles to old appliances. An excellent example of this difficulty is seen in the attempts to use superheated steam, and to obtain in practice the benefits which undoubtedly belong to it in theory. In a paper in a recent issue of the *Revue de Mécanique,* M. Delaporte examines the real advantages which may be expected from the use of superheated steam, taking into account the important fact that the medium is to be used in existing engines, machines admittedly imperfect appliances for the conversion of heat energy into mechanical power.

The discrepancies found between the computed and observed results in reciprocating steam engines have not been unexpected. since an important source of error is well understood to exist, namely the action of the cylinder walls upon the steam. Although a number of brilliant investigations have been made upon this important question our knowledge is still so imperfect that it is impossible to reduce the relations to the mathematical form of equations. Undoubtedly the internal condensation and reevaporation may be materially reduced by the employment of superheating, and with the diminution of losses from this cause we may be able to discover and study other sources of error. Here, however, we encounter a curious fact. In the case of the steam turbine the influence of changing temperatures of cylinder walls does not exist, because the continuous flow of steam through the machine causes each point to be maintained at a constant temperature. Under such conditions it would be reasonable to suppose that a close approximation to the theoretical performance would be attained, but experience has shown that with the steam turbine a marked improvement in economy is effected by superheating. Apparently the benefits of superheating are as great in those machines in which the injurious action of the walls does not exist as in the case where internal condensation is known to occur. A certain portion of the gain in the steam turbine with superheated steam has been attributed to the diminished friction of the discs against the drier steam, but M. Delaporte considers this explanation wholly inadequate to account for the results of observation. On the contrary, he maintains that the discrepancy is due to an improper use of thermodynamic formulas, applying to machines essentially imperfect equations deduced from assumptions which are true only for perfect engines.

M. Delaporte makes a thorough mathematical examination of the actual conditions of heat transfer in engines of one and several cylinders, employing the temperature-entropy diagram, and also makes the same analysis for the steam turbine, but it is impracticable for us to discuss here in detail the results of these investigations. The general conclusions, however, show that the gain due to superheating is largely due to the fact that the machines are but imperfect appliances for the conversion of heat energy into work, and that it is upon this imperfect action that the possibility of gain depends.

An important element in all such computations is the fact that the specific heat of superheated steam is by no means accurately known. The value usually taken is that of Regnault, being 0.48 or 0.485, but this has been considered by many as being too low, and the recent researches of Bach, show that its value is probably more nearly equal to 0.6. Further experiments upon this question are greatly to be desired. The theoretical examination of this portion of the subject by M. Delaporte, using the equations of Zeuner, shows that the specific heat of saturated steam increases with the pressure, and also that, according to the investigations of Hirn, the value of the specific heat of superheated steam might reasonably be expected to be somewhere about 0.6 to 0.65.

While the practical advantages of superheating are not to be denied, there is certainly room for further experimental investigations into the true causes for the economy effected by its use. This is especially the case in connection with the rapid development of the steam turbine, as this motor bids fair to supersede the reciprocating engine for very many purposes, and improvements in its performance must depend very largely upon a correct knowledge of the thermodynamic principles involved. The whole subject forms material eminently suitable for work in the engineering laboratory, and although some excellent work has been done in this direction at Zürich and elsewhere, the matter is by no means exhausted.

GAS-ENGINE DESIGN.

RECENT DEVELOPMENTS IN THE CONSTRUCTION AND WORKING OF INTERNAL-COMBUSTION ENGINES.

D. S. Capper—Junior Institution of Engineers.

IT is remarkable that the internal-combustion motor has, until the last few years, remained almost entirely in the form and design which was given to it by Dr. Otto more than thirty years ago. Originally intended for small engines, the design has simply been magnified for larger ones, and the whole matter was treated empirically for a long time. Now that the demand for large engines has appeared, and the commercial world is demanding all that can be practically obtained as regards efficiency, uniformity of speed and continuity of operation, the internal-combustion motor has become the subject of serious study by the designing engineer, and on the whole with excellent results. An interesting review of the recent development in this line of work is found in a paper presented by Professor D. S. Capper before the Junior Institution of Engineers, from which we make some abstracts.

The first improvement of any importance made in the original Otto engine was the substitution of the incandescent tube for the troublesome flame ignition slide. This was followed by a revival of the use of electric ignition, originally employed by Lenoir in his historic engine, so that the flame ignition has been altogether abandoned. Electric ignition is now the rule; although the heat of compression or the accumulated

of combustion is used in some in-
ces.

far as improvements in efficiency are
erned, these mainly depend upon the
ased degree of compression used.
Messrs. Crossley, the builders of the
engine in England have succeeded in
ng the compression from 30 pounds per
re inch to 100, or even 120, pounds.
involves correspondingly high combus-
temperatures, and improved methods
oling have been found necessary, ex-
t valves and pistons, as well as cylin-
barrels, being water-cooled.

hermodynamically, the raising of the
ression pressure makes the compres-
correspond more closely to the adiabatic
n from lowest to highest temperature
e Carnot cycle, but the isothermal stage
e Carnot cycle has to be omitted almost
ely. Moreover, with a rich, gaseous
ure the compression cannot be carried
igh as desirable from the theoretical
of view, as the critical ignition pres-
and temperature for the mixture would
eached and pre-ignition would auto-
ally take place.

he successive increases in compression
ure, accompanied by other improve-
s, have resulted in the consumption of
gas per brake horse-power in the Cross-
ngine being reduced from 25 cubic feet
ccessive stages to 17, 15 and 13.5 cubic
per brake horse-power per hour, which
s, with gas of calorific value equal to 680
pounds per cubic foot, a thermal effi-
y on the effective work of 27.6 per cent.
gas from a producer or blast-furnace
onsumption would be greater in pro-
on to the quality of the gas.

e earliest attempt to construct an en-
with a power stroke every revolution
made by Dugald Clerk about 1876, his
e being constructed with a separate
ressing pump, instead of effecting the
ression in the working cylinder. Clerk
introduced the practice of scavenging
ylinder with fresh air to remove the
cts of the previous combustion, and
ugh his engine did not come into gen-
use, many of the later designs include
of his original ideas.

fessor Capper reviews the improved
es *constructed by the Westinghouse*
any, by the Premier Gas Engine
Company, by the Cockerill Company, by Messrs. Fielding and Platt, and others, these including multiple cylinders, vertical arrangement, governing by varying the gas mixture, and many improved structural details. In general the Otto cycle is still principally used, its drawbacks being overcome by the use of heavy fly-wheels, careful governing, and by the grouping of a number of cylinders round the crankshaft in such a manner as to reduce the floor space occupied to a minimum. Further, by improved arrangement of parts, reduction of clearance, and increased attention to minimizing the area in contact with the hottest gases and an accompanying increased efficiency and extent of cooling jacket, the engine is showing signs of developing into a double-acting engine. It has thus been found possible to obtain a direct gas-driven electric generator set, occupying no more space than a steam-driven set of equal power.

Professor Capper examines the Diesel motor at length, discussing especially its availability as a gas engine, and shows that it would require but slight modification to adapt it to gas fuel, and thus to realize the object long ago attempted by Sir William Siemens of producing a gas engine with constant-pressure ignition.

"From these facts it will be gathered that the gas engine has been, by recent improvements in construction brought to a position in which, in economy, it surpasses the steam-engine, and in regularity of running, steadiness, size and handiness for given power, it approaches very closely, and promises to surpass, the steam-engine also. Compound gas-engines have been tried by Messrs. Crossley and by other makers; but although these have been successfully worked, the gain has not been commensurate with the added cost, and they have therefore not been adopted as a commercially possible type.

"If the reciprocating engine were to give place to a rotary turbine, there is little doubt that its future bids fair to equal—probably to surpass—the steam-engine for universal applicability. Many experimenters are working on the problem of a gas-turbine, and there are even rumors that a solution has been found. There is little doubt that as Mr. Parsons has converted the engineering world to the real genuineness of an economical steam-turbine (though many of us had, from frequent disappointment, learned to regard a rotary engine as approaching perpetual motion in the improbability of its successful achievement), so the gas-turbine will in the future—possibly the near future—be an accomplished fact. The place the reciprocating gas-engine has already won is proved by the significant fact that even firms which have created the demand and met the supply for high-speed steam electric generators are almost without exception experimenting with gas engines as the coming thing which will supply the second, if not the first, string to their bow."

THE NEW SUSPENSION BRIDGE AT NEW YORK.

NOTES CONCERNING THE WILLIAMSBURG BRIDGE ACROSS THE EAST RIVER AT NEW YORK CITY.

Engineering News.

FOR more than twenty years the Brooklyn suspension bridge over the East River at New York has been one of the sights of the metropolis, both for its length of span and the importance of the traffic, as well as for the beauty of its appearance. Now, however, it has to share all of these features with a rival, since the greatly needed bridge spanning the same river about a mile and a half further north is completed and open for traffic.

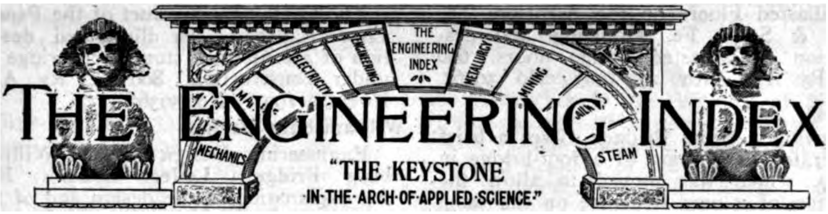
Illustrations and details of this important structure have already been given to the public in many of the engineering publications, but some salient features may here be noted for convenient reference, and from an excellent description in *Engineering News* we gather the following points.

The new bridge is five feet greater in span than the Brooklyn bridge, but in capacity for traffic it exceeds the older structure threefold, and it is in this respect especially that the new bridge is notable. Many bridges of great span have been constructed to meet the demand for a communication, important in character but limited in volume. The immense traffic between the two boroughs of New York, Manhattan and Brooklyn, has long since crowded the old suspension bridge to its limits, and every feature in the design of the new structure has been considered with a view of providing for the various kinds of transport demanded.

A few figures may be given to enable the old, or Brooklyn, bridge to be compared with the new, or Williamsburg, bridge. The Brooklyn bridge is of 1,595.5 feet clear span, and a total length of 5,989 feet. Its clear height of waterway beneath is 135 feet, and the width of the bridge structure proper is 85 feet. The Williamsburg bridge has a span of 1,600 feet and a clear height of 140 feet 4¾ inches above mean high water, while the width is 118 feet. The traffic capacity of the Williamsburg bridge is increased by making a portion of the suspended structure double deck, there being two roadways and two tramways for electric trolleys on the lower deck, while above there are two foot walks, two bicycle paths, and a double track way for the elevated railway. This arrangement will provide fully triple the transport capacity for the new bridge over the old, and this will doubtless materially relieve the crowding of the Brooklyn bridge, besides aiding to develop the section more directly reached by the new structure.

The principal differences in appearance between the new bridge and the Brooklyn bridge are of the towers, which are of structural steel instead of masonry, and in the much greater depth and stiffness of the suspended structure, this latter being practically an immense truss bridge supported by the cables instead of by piers. This latter feature gives the new bridge a great degree of stiffness, and it is expected that even with the greatest traffic of which the roadways are capable the deflection and vibration will be almost imperceptible.

The new bridge was commenced in October, 1897, and opened in December, 1903, and the total cost, exclusive of the site, was about $11,000,000; inclusive of the land, however, the cost has exceeded $20,000,000. The Chief Engineer of the bridge was Mr. L. L. Buck, and the Assistant Chief Engineer Mr. O. F. Nichols.



THE ENGINEERING INDEX

"THE KEYSTONE IN THE ARCH OF APPLIED SCIENCE."

The following pages form a DESCRIPTIVE index to the important articles of permanent value published currently in about two hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every article.

(1) The full title,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published.

We supply the articles themselves, if desired.

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer and works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of any article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the journals indexed are given.

DIVISIONS OF THE ENGINEERING INDEX.

CIVIL ENGINEERING 761
ELECTRICAL ENGINEERING 766
GAS WORKS ENGINEERING 773
INDUSTRIAL ECONOMY 774
MARINE AND NAVAL ENGINEERING 775
MECHANICAL ENGINEERING 777
MINING AND METALLURGY 787
RAILWAY ENGINEERING 791
STREET AND ELECTRIC RAILWAYS 794

CIVIL ENGINEERING

BRIDGES.

Basel.

The Temporary Bridge over the Rhine at Basel (Die Provisorische Rheinbrucke in Basel). Illustrating the wooden structure for use during the rebuilding of the middle bridge at Basel. 1500 w. Schweizerische Bauzeitung—Nov. 7, 1903. No. 59824 B.

Cantilevers.

Some Considerations on the Effect of Stresses on Cantilevers. T. Mackenzie. Considers a simple approximate method of determining the amount of vertical displacement, or the deflection of levers under various conditions of load, etc. 1600 w. Builder—Nov. 28, 1903. No. 59430 A.

Erection.

Erection of the Turtipar Bridge on Barges and Cantilever Falsework. Brief description of the unusual manner of erecting a bridge across the Gogra River, India. 700 w. Eng Rec—Dec. 5, 1903. No. 59475.

Floors.

Ballasted Floors on the Atchison, Topeka & Santa Fe. Drawings and description of ballasted bridge floors. 600 w. Ry Age—Nov. 27, 1903. No. 59365.

Moving.

Moving a Seine Bridge. Gives a brief illustrated description of a foot-bridge in Paris, which was moved to allow the erection of a new structure on the same site, explaining the conditions and the methods. 1600 w. Engr, Lond—Dec. 11, 1903. No. 59738 A.

Reinforced Concrete.

75-ft. Concrete Steel Arch on the Burlington. An illustrated description of a structure being built over Big Rock Creek, 51 miles from Chicago. 1000 w. R R Gaz—Dec. 1, 1903. No. 59522.

See also Civil Engineering, Construction.

Stress.

The Limits of Working Stress in Bridges. On the considerations which determine the limits of working stress in bridge structures, with examples of the limits actually adopted in the case of important bridges. 3500 w. Engr, Lond —Nov. 29, 1903. Serial, 1st part. No. 59349 A.

Suspension.

Eye-Bars or Cables for Manhattan Bridge. R. S. Buck. A comparison of theories and conditions, with detailed discussion of material cost, methods, &c. Also editorial. Illustrated. 11700 w. R R Gaz—Dec. 4, 1903. No. 59488.

The Manhattan Bridge Design. Gustav Lindenthal. A letter stating the reasons for the chain bridge. 1400 w. R R Gaz —Dec. 25, 1903. No. 59922.

The Superstructure for the Manhattan Bridge Across the East River at New York City. General description, with illustrated description of special details. 2000 w. Eng News—Dec. 10, 1903. No. 59526.

Towers and Anchorages of the Manhattan Bridge, New York. Illustrated description prepared from the specifications and drawings issued by Commissioner Lindenthal. 2000 w. Eng Rec—Dec. 12, 1903. No. 59595.

Transporter.

Transporter Bridges (Ponts à Transbordeur). G. Leinekugel Le Cocq. With illustrated descriptions of the bridges at Rouen, Bizerte and Nantes. A travelling car is suspended from a high level suspension bridge, thus permitting a clear waterway for ships. Two articles. Two plates. 5000 w. Génie Civil—Nov. 21, 28, 1903. No. 59802 each D.

Viaduct.

The Coatesville Viaduct of the Pennsylvania Railroad. An illustrated description of a four-track stone arch bridge now under construction. 800 w. Ry Age—Nov. 27, 1903. No. 59367.

Williamsburg Bridge.

Engineering Design of the Williamsburg Bridge. Leffert Lefferts Buck. An explanation of the design and of features suggested which have not been carried out in the construction of the new bridge over the East River, New York. 2000 w. R R Gaz—Dec. 25, 1903. No. 59923.

The Main Span of the Williamsburg Bridge, Across the East River, New York City. Begins an illustrated detailed description of the operation of erecting the suspended superstructure of this long-span bridge. 2000 w. Eng Rec—Dec. 19, 1903. No. 59668.

The Opening of the New East River Bridge, New York. An exhaustive illustrated account of the construction from the engineering standpoint. 9500 w. Sci Am Sup—Dec. 19, 1903. No. 59709.

The Williamsburg Bridge Across the East River at New York City. An illustrated detailed description of the construction of this bridge just opened to traffic. 11200 w. Eng News—Dec. 17, 1903. No. 59701.

CANALS, RIVERS AND HARBORS.

Breakwater.

The Breakwater at Buffalo, New York Emile Low. An illustrated detailed description of breakwater construction and extension, with history of the projects for the formation of a harbor, maps, &c. 36400 w. Pro Am Soc of Civ Engrs—Nov., 1903. No. 59303 E.

Brussels.

Brussels as a Seaport (Bruxelles Maritime). E. Guarini. An account of the cutting of the canal which is to connect Brussels with the North Sea. 2000 w. Revue Technique—Nov. 25, 1903. No. 59829 D.

Canal Lifts.

Improved Methods of Overcoming High Canal Lifts (Neuere Vorschläge zur Ueberwindung Hoher Stufen in Schiffahrtskanälen). H. R. Rintelen. A review of various schemes for replacing canal locks, including movable tanks, inclined planes, etc. 5000 w. Glasers Annalen—Dec. 15, 1903. No. 59845 D.

Cofferdam.

Cofferdam for the 39th Street Pumping Station at Chicago. Illustrates and describes what is believed to be the largest m ever built in open water. 500 g News—Dec. 17, 1903. No. 59703.

Meters.

Mechanical Engineering, Hydraul-

g Moveable Dams (Ueber Walz- e). M. Carstanjen. The dam is n the form of a large cylindrical which can be rolled up inclined permit the free passage of flood Details and illustrations of existallations are given. 5000 w. Zeit- . Oesterr Ing u Arch Ver—Dec. 11, No. 59822 D.

lso Civil Engineering, Water Sup-

Improvements at Liverpool. Dis- of a paper by George Cecil Ken- 200 w. Pro Am Soc of Civ Engrs 1903. No. 59785 E.

d-Ems.

Dortmund-Ems Canal and Hen- urg Canal Lift. An illustrated de- description of this famous canal th outline of the project of which s a part. 4800 w. Trac & Trans 1903. Serial. 1st part. No. 59-

sirable Method of Dredging Chan- rough River Bars. Discussion by Rudolph Hering and W. W. of a paper by S. Maximoff. 1500 Am Soc of Civ Engrs—Dec., No. 59787 E.

ging Plant and Clyde Improve- Illustrated description of a power- n-screw barge-loading dredge built rk on the Clyde. 1200 w. Engr, Dec. 18, 1903. No. 59781 A.

Chaquette Pneumatic Dredge. C. enport. An illustrated detailed de- n of a power clamshell for dredg- excavating. 2700 w. Compressed ec., 1903. No. 59558.

s.

arine and Naval Engineering.

on Harbor Works and Harbor Discusses the principal types of es and plant used in harbor, pier akwater work at the present time. . Builder—Dec. 19, 1903. Serial. . No. 59760 A.

al Navigation in Italy (La Navi- Interna in Italia). G. Cattaneo. amination of present conditions, r with future plans, with especial e to the *canalisation of the rivers* of Northern Italy. 10000 w. 2 plates. Rivista Marittima—Aug., Sept., 1903. No. 59871 H.

New York.

Recent Changes in the Elevation of Land and Sea in the Vicinity of New York. Abstract of a paper by George W. Tuttle. Gives conclusions reached as the result of a study of tidal observations—1500 w. Eng Rec—Dec. 12, 1903. No. 59596.

Panama.

Organization and Personnel in the Building of the Panama Canal. Fullerton L. Waldo. A discussion of an outline of practical plans for the actual construction work on the canal. 2500 w. Engineering Magazine—Jan., 1903. No. 59883 B.

Notes on Panama and Colombia. An account giving population, area, and general information of each. Ill. 1600 w. Nat Geog Mag—Dec., 1903. No. 59381 C.

The Solution of the Isthmian Canal Problem. Gen. H. L. Abbot. A review of the dangers which have been escaped by the choice of the Panama route for the Isthmian Canal. 3000 w. Engineering Magazine—Jan., 1903. No. 59882 B.

River Improvement.

The Work of the Madison Park and Pleasure Drive Association, Madison, Wis. W. D. Taylor. Illustrates and describes the improvement of the Yahara River by cleaning and deepening the river bed by dredging, raising the bridges, securing the land on both banks for driveways, etc. 1500 w. Eng News—Dec. 10, 1903. No. 59524.

CONSTRUCTION.

Domes.

Theory of the Spherical Dome with a Homogeneous Surface, and of the Framed Dome; Also Notes on the Construction of Masonry and Metal Domes. E. Schmitt. Gives original information, and shows the relation between the principal stresses in domes, and their magnitude; and presents a method of framed dome construction. Ill. 8000 w. Pro Am Soc of Civ Engrs—Dec., 1903. No. 59784 E.

Erection.

A Comparison of English and American Methods in the Erection of Buildings. Charles Heathcote. Read before the Inst. of Builders. 5200 w. Builder—Dec. 5, 1903. No. 59611 A.

Excavating.

The Practical Working of Trench Excavating Machinery. Ernest McCullough. Illustrates and describes a trench-excavating machine and its operation. 2500 w. Eng News—Dec. 24, 1903. No. 59755.

Foundations.

Foundations. Baron H. T. H. Siccama. Read before the Civ. & Mech. Engrs, Soc. and printed in the *Building News*. An interesting review of systems used in alluvial soils. 3800 w. Am Archt—Dec. 19, 1903. No. 59661.

Grain Elevator.

The Southern Pacific Elevator, Galveston, Texas. Illustrated description of an interesting engineering work. 3500 w. Eng Rec—Dec. 5 1903. No. 59473.

Granite Columns.

The Production and Transportation of the Granite Columns for St. John's Cathedral, New York City. An illustrated article describing this difficult work and explaining the methods adopted. 2800 w. Eng News—Dec. 3, 1903. No. 59486.

Reinforced Concrete.

An Armored Concrete Building for the College of Music, Cincinnati. Brief description of moderate cost, fire-resisting building, with illustrations of details. 1000 w. Eng Rec—Nov 28, 1903. No. 59377.

A Suspended Curved Double Stairway of Reinforced Concrete. Illustrates and describes a winding stairway being built in the New York residence of Mr. George W. Vanderbilt. 1500 w. Eng Rec—Dec. 12, 1903. No. 59594.

Concrete Metal Construction. Emile Villet. An illustrated description of work in the art of armoured cement construction, discussing the wharf at the port of Novorossisk, on the Black Sea, Russia; the wharf for the Department of Docks, of New York; and a proposed sea-wall for San Francisco. 3700 w. Jour Assn of Engng Soc's—Oct., 1903. No. 59576 C.

Concrete-Steel Columns for Reinforcing an Old Building. Keith O. Guthrie. Illustrated description of method adopted to strengthen 10th Sub Station of the Louisville Lighting Co. 1000 w. Eng News—Dec. 17, 1903. No. 59704.

Ferroinclave—A Fireproof Building material. H. F. Cobb. Read before the Civil Engr.'s Club of Cleveland. An illustrated description of a fireproof roofing construction of reinforced concrete. 2800 w. Ir Trd Rev—Dec. 17, 1903. No. 59684.

The Concrete-Steel Stadium on the Athletic Field of Harvard University. Illustrations and description of a structure being erected for open-air games. 2200 w. Eng Rec—Dec. 12, 1903. No. 59597.

See Also Civil Engineering, Bridges.

Roads.

Good Roads. George C. Diehl. Reviews what has been done in road improvement, the methods employed to advance the work, &c. 3000 w. Jour Assn of Engng Soc's—Oct., 1903. No. 59575 C.

Roofs.

Roofing Existing Shops While Work is Proceeding. R. H. Fowler. An illustrated description of methods used in re-roofing the shops of the steam plough works at Leeds, Eng. 1600 w. Inst of Mech Engrs—Nov. 20, 1903. No. 59313 D.

Some Roof Trusses in the Hotel Astor. Description, diagrams and details of mansard roof framing. 1500 w. Eng Rec—Dec. 5, 1903. No. 59474.

Subaqueous Construction.

An Improved Method of Subaqueous Construction at the Harlem River Crossing of the New York Rapid Transit Railroad. Illustrates and describes the method used near 145th street. 1300 w. Eng Rec—Dec. 26, 1903. No. 59909.

Tunnels.

Some Tunnel Work on the Pittsburg, Carnegie & Western R. R. An illustrated account of tunnels now under construction on the Wabash R. R. extension, having features of unusual engineering interest. 3000 w. Ry & Eng Rev—Dec. 5, 1903. No. 59464.

The Cost of Concrete Tunnel Lining and of Tunnel Excavation. George W. Lee. An illustrated article describing methods of construction and giving figures showing the cost of this kind of work. 1800 w. Eng News—Dec. 17, 1903. No. 59699.

The East River Tunnel. Interesting illustration with description of construction work on this tunnel which is to connect Brooklyn and Manhattan. 1800 w. Compressed Air—Dec., 1903. No. 59559.

The Present Status of the Hudson River Tunnel. Reviews the history of the construction work of the tunnel begun 30 years ago. 1200 w. Ir Age—Dec. 17, 1903. No. 59626.

Underpinning.

Underpinning an Old Office Building on Broadway, New York. Diagram and description of counter-weighted cantilever needle beams and girders for underpinning, and methods used. 1000 w. Eng Rec—Dec. 5, 1903. No. 59476.

Ventilation.

Distribution of Air. Alton D. Adams. The present article is introductory, showing the great importance of proper ventilation, and causes of vitiation. 2000 w. Archts & Builders Mag—Dec., 1903. Serial. 1st part. No. 59443 C.

MATERIALS.

Cement.

Edison Portland Cement Company. An

illustrated description of the extensive plant at New Village, N. J., and the novel processes of manufacture employed. 6500 w. Ir Age—Dec. 24, 1903. No. 59743.

The Edison Portland Cement Works at New Village, N. J. An illustrated detailed description of these works and their operation. The distinctive feature is the use of roll crushers and grinders. Also editorial. 5500 w. Eng News—Dec. 24, 1903. No. 59794.

The Fatigue of Cement-Products. Discussion of paper by J. L. Van Ornum. 1500 w. Pro Am Soc of Civ Engrs—Nov., 1903. No. 59304 E.

The Manufacture of Artificial Portland Cement (Fabrication du Ciment Portland Artificiel). A. Morel. A general description of the different processes, furnaces, and grinding machinery. Three articles. 5000 w. Génie Civil—Nov. 28, Dec. 5, 12, 1903. No. 59804 each D.

The Plant of the Northampton Portland Cement Company. Richard K. Meade. Illustrated detailed description. 2000 w. Eng Rec—Dec. 5, 1903. No. 59472.

Concrete.

Mixing and Placing Concrete. Samuel H. Lea. Discusses placing forms, facing, methods of handling under water or in freezing weather, waterproofing, etc. Ill. 6000 w. Mines & Min—Dec., 1903. No. 59385 C.

Staff.

Staff—Its Use and Treatment. J. S. Crawford. An illustrated article giving facts of interest in regard to the treatment of this material, which is extensively used in exposition buildings and their ornamentation. 3000 w. Sci Am—Dec. 5, 1903. No. 59479.

MEASUREMENT.

Surveying.

The Accuracy of Surveying Measurements for Tunneling (Ueber den Genauigkeitsgrad der Messungen für Anlage und Bau von Tunneln). F. Haller. Discussing the method of determining the probable error in a system of triangulation. 2000 w. Schweizerische Bauzeitung—Nov. 7, 1903. No. 59825 B.

Theodolite.

Ferguson's "Percentage" Theodolite. Illustrates and describes a tacheometer theodolite in which is embodied a method of graduating the arcs. 800 w. Engng—Dec. 4, 1903. No. 59636 A.

MUNICIPAL.

Pavements.

Use of Medina Sandstone for Pavements in Brooklyn, New York City. C. D. Pollock. *Gives the specifications* for blocks and methods of laying. 1200 w. Eng Rec—Dec. 26, 1903. No. 59906.

Sewage.

Sewage Disposal at Provincial Gaol, Victoria, B. C. E. Mohun. Drawing and description of the method adopted in an isolated plant. 1100 w. Can Soc of Civ Engrs, Adv proof—Dec., 1903. No. 59675 D.

Sewage Disposal in Providence. Illustrated description of a plant employing the chemical precipitation method, its cost and operation. 1500 w. Munic Jour & Engr—Dec., 1903. No. 59409 C.

Sewage Disposal. Rudolph Hering. Part of a paper read before the League of Am. Munic. Cives an expert's views, describing the practice in foreign cities, and the best methods in the United States. 2000 w. Munic Jour & Engr—Dec., 1903. No. 59410 C.

The Use of Sewage for Irrigation After Treatment in Septic Tanks in Tropical Countries. E. O. Mawson. Deals with small schemes, suitable for medium-sized towns, showing how the sewage can be turned to profit. 3000 w. Fielden's Mag—Dec., 1903. No. 59619 A.

Sewer Construction.

Inverted Syphons in the Sewage System of Newton, Mass. Irving T. Farnham. Explains why these syphons were necessary and their essential features. Ill. 1000 w. Munic Engng—Dec., 1903. No. 59548 C.

Smoke.

The Smoke Problem of Denver. Thomas L. Wilkinson. The present article gives a survey of what has been done in other cities to abate the smoke nuisance. It will next consider combustion in boiler furnaces, showing how the smoke may be overcome. 2200 w. Min Rept—Dec. 10, 1903. Serial. 1st part. No. 59605.

WATER SUPPLY.

Cleveland, O.

The New Water Supply Tunnel of Cleveland, Ohio. Charles Goffing. Gives a brief resumé of the history of the East Side lake tunnel and its construction. 1500 w. Eng Rec—Dec. 12, 1903. No. 59599.

Consumption.

Water Consumption in American Cities. E. Kuichling. A study in water meter statistics by an expert engineer. 1500 w. Munic Jour & Engr—Dec., 1903. No. 59412 C.

Dam.

The Walden Pond Dam of the Lynn Water Works. George A. Leland. Reviews the history of the supply, and gives an illustrated description of the work of raising this dam 20 feet. 3000 w. Eng Rec—Dec. 19, 1903. No. 59670.

Filtration.

Filtration for Public Water Supplies, with Especial Reference to the Double Filtration Plant at Bremen, Germany. Discussion of the paper by Eugen Goetze, Esq. 4500 w. Pro Am Soc of Civ Engrs—Nov., 1903. No. 59305 E.

Filtration for Public Water Supplies, with Especial Reference to the Double Filtration Plant at Bremen, Germany. Continued discussion of a paper on this subject by Eugen Goetze. 12400 w. Pro Am Soc of Civ Engrs—Dec., 1903. No. 59786 E.

The Mechanical Filter Plant for the Danville Water Company. An illustrated detailed description of new works. 1800 w. Eng Rec—Dec. 26, 1903. No. 59905.

The Use of Sulphate of Iron at Lorain. C. Arthur Brown. Report concerning changes made in a filtration plant on Lake Erie, the methods of analysis, results obtained, &c. 2800 w. Eng Rec—Dec. 5, 1903. No. 50478.

New York City.

Abstract of report of the Commission on an Additional Water Supply for New York City. With map and editorial comment. 5000 w. Eng Rec—Dec. 19, 1903. No. 59675.

Final Report of the Commission on Additional Water Supply for the City of New York. Abstract and map. 1500 w. Eng News—Dec. 24, 1903. No. 59798.

Ozone.

Recent Applications of Ozone in Water Sterilization (Weitere Beiträge zur Technik der Ozonwasserwerk). Dr. G. E. Erlwein. Data and results of recent investigations into the sterilization of drinking water by ozone. 3000 w. Gesundheits-Ingenieur—Oct. 31, 1903. No. 59878 D.

See also Electrical Engineering, Electrochemistery.

Pollution.

The Typhoid Fever Epidemic at Butler, Pa. George A. Soper. Report of investigation showing the epidemic to be due to the use of polluted water, by reason of the interruption in the operation of the filter plant. 6000 w. Eng News—Dec. 24, 1903. No. 59799.

Rainfall.

Rainfall and Run-Off of New England, Atlantic Coast and Southern Colorado Streams. William O. Webber. Tabulated information with explanatory notes. General discussion. 15000 w. Jour Assn of Enging Socs—Nov., 1903. No. 59788 C.

Reservoirs.

New Reservoir at Portland. Description of basin just completed near Sebago Lake, Maine. 1800 w. Fire & Water—Dec. 5, 1903. No. 59463.

The Cedar Grove Reservoir of the Newark, N. J., Waterworks. The present article gives a general illustrated description, dams, and contractor's plant. 2500 w. Eng Rec—Dec. 5, 1903. Serial. 1st part. No. 59471.

The Staines Reservoirs and Aqueducts of the London Water Works. Illustrated detailed description. 4500 w. Eng Rec—Nov. 28, 1903. No. 59375.

Springfield, O.

Springfield's Water Supply. L. Walter Harrison. A description of a water supply filtered bv nature. Ills. 1000 w. Munic Jour & Engr—Dec., 1903. No. 59411 C.

MISCELLANY.

Drainage.

Some Engineering Features of Drainage. C. G. Elliott. From the *Year Book* of Department of Agriculture. Considers briefly drainage of rainfall, surface storage, irrigated lands, etc., etc. Ill. 6000 w. Sci Am Sup—Dec. 5, 1903. No. 59482.

House Raising.

Raising a Brick Dwelling One Hundred and Sixty Feet. Illustrates and describes a remarkable job of house raising and moving recently successfully accomplished in Pittsburg. 1200 w. Eng Rec—Dec. 19, 1903. No. 59674.

Rural Engineering.

Rural Engineering. Condensed report of the Committee on Rural Engineering of the Assn. of Am. Agri. Colleges and Ex. Stations. Deals with drainage, irrigation, farm requirements, etc. 3000 w. Eng News—Dec. 24, 1903. No. 59796.

ELECTRICAL ENGINEERING

COMMUNICATION.

Space Telegraphy.

A New Wave Detector for Wireless Telegraphy (Ein Neuer Wellendetektor für Drahtlose Telegraphie). W. Schloemilch. Describing a new form of electrolytic detector, using a polarized cell. 2000 w. Elektrotech Zeitschr—Nov. 19, 1903. No. 59855 B.

Concerning Wireless Telegraph Transmitters. Lee de Forest. Discusses some of the causes of failure, and reviews points that should be observed in the erection of apparatus. 1800 w. Elect'n, Lond—Nov. 27, 1903. No. 59435 A.

Electrical Notes from Europe. Illustrates and describes the automatic wireless telegraph post at Paris, and the new Blondel-Carpentier hysteresimeter. 2500 w. Elec Rev, N. Y.—Dec. 5, 1903. No. 59466.

Some New Experiments in Syntonic Wireless Telegraphy in the Italian Navy. Describes experiments of considerable interest. 3700 w. Sci Am Sup—Nov. 28, 1903. No. 59338.

The Multiplication Scale as a Wave Measurer for Space Telegraphy (Der Multiplikationsstab ein Wellenmesser für die Funkentelegraphie). A. Slaby. A discussion of the author's methods for syntonizing apparatus for selective space telegraphy. 5000 w. Elektrotech Zeitschr —Dec. 10, 1903. No. 59862 B.

Telephone Exchange.

Methods of Signaling and Operating in Telephone Exchanges. Kempster B. Miller and Charles S. Winston. Explains some points in the standardized practice, and why they are regardless, as far as possible, of any circuit arrangement. 2500 w. Elec Wld & Engr—Dec. 5, 1903. Serial. 1st part. No. 59493.

The Exchange of the Frontier Telephone Company, Buffalo, N. Y. Virgil Hayden. Illustrated description. 2400 w. Elec Rev, N. Y.—Dec. 26, 1903. No. 59916.

The New Douglas Exchange of the Chicago Telephone Company. Illustrated description. 4500 w. Am Elect'n—Dec., 1903. No. 59415.

Telephony.

Some Elements Inherent in Automatic Telephony Which Make It Popular. Joseph B. Baker. Discusses the character and advantage of the automatic service. 1700 w. Elec Rev, N. Y.—Dec. 12, 1903 No. 59577.

Transmitters.

Telephone Transmitters. Arthur V. Abbott. Explains the three principles upon one of which every transmitter operates, and discusses microphonic contact in the present article. Ill. 2800 w. Elec Wld & Engr—Dec. 5, 1903. Serial. 1st part. No. 59494.

DISTRIBUTION.

Converter.

Investigations of the Pulsation of the Continuous Current in a Rotary Converter (Untersuchungen über die Pulsation des Gleichstromes bei dem Rotierenden Umformer). E. Cramer. A repetition of the investigations of Banti, showing the influence of the pulsations upon the determination of efficiency. 7000 w. Elektrotech Zeitschr—Nov. 19, 1903. No. 59854 B.

Montreal.

Montreal the Greatest Center of Transmitted Power. Alton D. Adams. The first installment of an illustrated account of the Montreal system. A great consolidation and the long-distance transmission problem are being worked out. 4000 w. Elec Wld & Engr—Dec. 5, 1903. Serial. 1st part. No. 59492.

Overhead Systems.

Overhead High-Tension Distributing Systems in Suburban Districts. George H. Lukes. Calls attention to certain points in pole line construction which experience has shown to be often neglected. 1600 w. Trans Am Inst of Elec Engrs—Dec. 18, 1903. No. 59652 D.

Safeguards and Regulations in Operation of Overhead Distributing System. W. C. L. Eglin. Discusses the conditions that must be considered in the construction of the line, the safety devices and their action, inspection, etc. 2800 w. Trans Am Inst of Elec Engrs—Dec. 18, 1903. No. 59654 D.

Regulation.

Automatic Apparatus for Regulating Generator and Feeder Potentials. E. J. Bechtel. Describes types of automatic generator potential regulators using different methods to accomplish the result. Ill. 1000 w. Trans Am Inst of Elec Engrs—Dec. 18, 1903. No. 59653 D.

Theft.

Theft of Current. Robert L. Elliott. Discusses some of the methods adopted by offenders, the discovery and prevention. 4800 w. Cent Sta—Dec., 1903. No. 59602.

ELECTRO-CHEMISTRY.

Accumulator.

See Mechanical Engineering, Automobiles.

Copper Refining.

Contact Resistances and Current Leakages in an Electrolytic Copper Refinery. Benjamin Magnus. Gives results of tests on tank leakages. Ill. 800 w. Elec-Chem Ind—Dec. 1903. No. 59514 C.

Deposition.

The Rapid Electro Deposition of Copper (Infringement Processes). Discusses what has been accomplished by this method. 1100 w. Elec-Chem and Met—Nov., 1903. No. 59651 E.

Electric Smelting.

Kjillin's Electric Furnace of Gysinge, Sweden, for the Manufacture of Steel.

Frank G. Perkins. Illustrated description. 1500 w. Elec-Chem Ind—Dec, 1903. No. 59516 C.

Production of Iron and Steel in the Electric Furnace. Dr. H. Goldschmidt. Abstract translation from the *Zeitschrift für Elektrochemie*. A descriptive article on electrical smelting of iron, giving a comparative statement of the various processes, the cost, &c. Ill. 3000 w. Elect'n, Lond—Nov. 20, 1903. No. 59355 A.

Electro-Metallurgy.

Practical Notes on the Electro-Depositing of Copper on Iron, Carbon and Zinc. Sherard Cowper-Coles. A review of apparatus and methods used and applications made. Ill. 6500 w. Elec-Chem and Met—Nov., 1903. No. 59649 E.

Industrial Applications.

Industrial Electrochemistry and Electrometallurgy. John B. C. Kershaw. The first section of a second series of notes dealing with recent progress in the industrial application of electro-chemical and electrometallurgical processes. 3700 w. Elec Rev, N. Y.—Dec. 5, 1903. Serial. 1st part. No. 59467.

Ozone.

The Production and Uses of Ozone. Illustrates and describes the more important forms of ozoniser which have been devised for the production of ozone in the air by means of the silent electric discharge, comparing the figures for their yield, and giving information concerning the earlier attempts made in Europe to apply this ozonised air to water purification. 3000 w. Engr. Lond—Nov. 20, 1903. No. 59351 A.

See also Civil Engineering, Water Supply.

Sodium.

The Sodium Industry in France. P. Letheule. An explanation of the electrolytic and electrochemic processes of H. Becker. 2000 w. Elec-Chem Ind—Dec., 1903. No. 59515 C.

ELECTRO-PHYSICS.

Air Electrifying.

Means for Electrifying the Atmosphere on a Large Scale. Sir Oliver Lodge, before the Physical Society. Outlines the method of discharging electricity into the air in times of fog, describing some effects. 1500 w. Elect'n, Lond—Nov. 20, 1903. No. 59356 A.

Alternating Currents.

Alternating Current Principles. George T. Hanchett. Explanatory notes. 2800 w. Cent Sta—Dec., 1903. No. 59601.

Condenser.

The Electrodynamic Condenser (Der Elektrodynamische Kondensator). J. Seidener. A discussion of the electrodynamic condenser of Leblanc and Swinburne as compared with the ordinary electrostatic condenser. 2000 w. Zeitschr f Elektrotech—Nov. 22, 1903. No. 59866 D.

Conductivity.

Tests of Steel for Electric Conductivity, with Special Reference to Conductor-Rails. J. A. Capp. Reports a series of tests made by the General Electric Co. on a wide range of steels, with a study of the results. 2800 w. Trans Am Inst of Min Engs—Oct., 1903. No. 59535.

Eddy Currents.

Experiments on Eddy Currents. W. M. Thornton. An account of experiments on cast iron and steel rings, tests on continuous and alternate current machines, magnetic field disturbance, &c. 6000 w. Elec Engr, Lond—Dec. 18, 1903. No. 59766 A.

Electric Convection.

Electric Convection—A Historical Summary with a Bibliography. J. Frank Meyer. 2500 w. Jour Fr Inst—Dec., 1903. No. 59552 D.

Electrons.

Electrons and Atmospheric Electricity. Discusses the value of the theory of electrons in determining weather probabilities and atmospheric changes. 2000 w. Elec Rev, Lond—Nov. 20, 1903. No. 59359 A.

Maximum Current.

Grouping of Cells to Obtain Maximum Current. Dr. K. E. Guthe. Discussion of this subject, outlining the method of solving a stated problem. 900 w. Elec Wld & Engr—Dec. 12, 1903. No. 59610.

Mercury Vapor.

Conductivity of Mercury Vapor. Peter Cooper Hewitt. Reports an investigation into the behavior of the mercury vapor and the results. Also editorial. 2200 w. Elec Rev, N. Y.—Dec. 19, 1903. No. 59678.

Radio-Activity.

Experiments in Radioactivity. H. Stanley Allen. Read before the Royal Philosophical Soc. of Glasgow. An account of facts observed and experiments carried out, showing some of the properties, with an outline of the history and preparation of radium. 4700 w. Engng—Dec. 4, 1903. No. 59640 A.

Radio-Active Substances. Mme. Sklodowska Curie—Condensed by Dr. J. Ohly. A report of the researches of Mme. Curie. 1500 w. Min Rept—Nov. 26, 1903. Serial. 1st part. No. 59334.

Radium and Radio-activity. Madame Sklodowska Curie. An account of the discovery of this substance, and its properties. 3800 w. Century Mag—Jan., 1904. No. 59901 D.

The New Element Radium. Ernest Merritt. An explanation of radioactivity, and account of investigations which have thus far been made, with report of the discovery of radium and its importance. 5000 w. Century Mag—Jan., 1904. No. 59900 D.

Roentgen Rays.

New Roentgen Ray Apparatus. Illustrated description of outfit. 1400 w. Sci Am Sup—Dec. 5, 1903. No. 59483.

Sun-Spots.

Influences of the Sun-Spots upon Electrical and Magnetic Forces of the Earth. William Finn. An account of investigations, and of theories. 2000 w. Sci Am Sup—Dec. 5, 1903. No. 59484.

Ultra-Violet Light.

Ultra-Violet Light and the Electric Discharge. Walter J. Turney. Describes experiments made. 1000 w. Sci Am Sup—Dec. 5, 1903. No. 59485.

Welding.

Some Notes on the Welding of Aluminum. Sherard Cowper-Coles. Read before the Faraday Soc. An illustrated article reviewing various processes and apparatus, and describing the writer's process and the tests made. 1600 w. Elec-Chem & Met—Nov., 1903. No. 59648 E.

GENERATING STATIONS.

Armatures.

The Best Dimensions for Armature Slots in Continuous-Current Dynamos (Ueber die Günstige Dimensionierung der Nuten von Gleichstromankern). A. Müller. A mathematical investigation, showing the best ratio the thickness of tooth to width of slot to be about 0.6. 1500 w. Zeitschr f Elektrotech—Nov. 29, 1903. No. 59868 D.

Central Station.

Reconstructed and enlarged Central Station. An illustrated description of the reconstructed plant of the Meriden Electric Light Company. 5000 w. Am Elect'n—Dec. 1903. No. 59413.

The Combined Use of Alternating and Direct Current for Central Station Work. Prof. F. C. Caldwell discusses various phases of the problem of what proportion of each should be used. 3500 w. Elec Rev, N. Y.—Nov. 28, 1903. No. 59372.

Direct Process.

A New Device for Producing Electrical Currents. Brief illustrated description of of apparatus devised by James H. Reid for producing energy direct from fuel, with editorial notes. 1200 w. Elec Rev, N. Y.—Dec. 12, 1903. No. 59579.

Dynamos.

A New Compounded Three-Phase Generator. Translation of an article by E. Kolben in *Electrotechnische Zeitschrift.* Describes a modification of the Heyland machine. Ill. 1000 w. Elec Engr, Lond Nov. 27, 1903. Serial, 1st part. No. 59432 A.

Continuous-Current Dynamos for Direct Connection with Steam Turbines. (Gleichstrommaschinen in Direkter Kupplung mit Dampf-Turbinen). Maximilian Zinner. Discussing the modifications of the commutator necessary to prevent sparking at high rotative speeds. 2500 w. Zeitsch f Electrotech—Nov. 29, 1903. No. 59867 D.

The Construction of Dynamos in Germany (La Construction des Dynamos en Allemagne). C. F. Guilbert. Illustrated description of the products of the principal German builders. Serial. Part I. 2000 w. Revue Technique—Nov. 25, 1903. No. 59828 D.

The Series and Parallel Operation of Generators. F. C. Caldwell. An illustrated discussion of cases. 1200 w. Engr U. S. A.—Dec. 15, 1903. Serial, 1st part. No. 59609 C.

Engine Driving.

See Mechanical Engineering, Steam Engineering.

Exeter Works.

The New Electricity Works at Exeter. Illustrates and describes a two-phase system. 3300 w. Elect'n, Lond—Dec. 11, 1903. No. 59721 A.

Extensions.

Recent Extensions of the Bradford Corporation Electrical Undertakings. An illustrated description of the developments of the last few years. 1700 w. Elec Rev, Lond—Dec. 18, 1903.. Serial, 1st part No. 59769 A.

Gas Power.

Gas-Power for Central Stations. J. R. Bibbins. On the advantage of operating electric stations in connection with gas works. 4000 w. Trans Am Inst of Elec Engrs—Dec. 18, 1903. No. 59655 D.

Hydro-Electric.

The Hydro-Electric Station at Avignonnet (Usine Hydro-Electrique d'Avignonnet). A. Dumas. An illustrated description of a station on the Drac, Department of Isère, France, where a fall of 23 metres is used to develop 5,500 horse power. Details of the dam and general construction are given. 3000 w. 1 plate. Génie Civil —Nov. 14, 1903. No. 59800 D.

The Lachine Rapids Power House of the Lachine Rapids Hydraulic and Land Company, Limited, Montreal. Illustrated description of this unique plant of low head and large capacity, and its method of operation. 7000 w. Can Soc of Civ

Engrs, Adv. Proof—Dec., 1903. No. 59658 D.

Isolated Plant.

Electric Lighting and Power Plant at the Tooting Bee Asylum. Illustrates and describes a plant having novel features. 1500 w. Elec Engr, Lond—Dec. 18, 1903. No. 59768 A.

Mechanical Stokers.

See Mechanical Engineering, Steam Engineering.

Niagara.

Recent Developments in Niagara Power. H. W. Buck. Illustrates and describes recent plants on both sides of the river. 2300 w. Cassier's Mag—Dec., 1903. No. 59744 B.

Rates.

A Method for Determining Rates and Prices for Electric Power. Frank B. Perry. Gives a method for rearranging a schedule of rates based on the "step-system." 2400 w. Trans Am Soc of Mech Engrs, No. 012—Dec. 1903. No. 59324.

Methods of Charging for Electrical Energy. Ellis H. Crapper. Abstract of a paper read before the Leeds Soc. of the Inst. of Elec. Engrs. Discusses the uniform meter rate, the two-rate meters and other systems. 3200 w. Elect'n, Lond—Dec. 18, 1903. No. 59771 A.

Reversals.

The Reversal of a Large Power Station. L. H. Pike. Describes conditions which led to the necessity of feeding lines in multiple with other stations, and the troubles met and overcome. Diagrams. 1500 w. Eng, U. S. A. Dec. 1, 1903. No. 59371 C.

Small Towns.

Destructor and Electricity Stations in Small Towns. S. D. Schofield. Abstract of a paper read before the Leeds Soc. of the Inst. of Elec. Engrs. Discusses the economy of this combination in the present article, showing the destructor is not a factor in the economical generation of electricity. 1400 w. Elec Engr, Lond—Nov. 27, 1903. Serial, 1st part. No. 59433 A.

South Africa.

Durban (S. Africa) Electric Light and Tramways. An illustrated description of a new combined power station, reviewing also the old works. 1500 w. Elec Rev, London—Dec. 11, 1903. Serial. 1st part. No. 59726 A.

Switchboards.

Switchboard Construction for Isolated Electric Plants. J. E. Woodwell. Describes the usual switchboard construction, calling attention to points of importance, and giving facts concerning the selection of the type of instruments and circuit breakers. 2500 w. Power—Dec., 1903. No. 59499 C.

Synchronizers.

Synchronizers and Parallel Operation of Dynamos. Arthur B. Weeks. On the use of voltmeters as synchronizers, and various cases in paralleling. Also brief illustrated description of the Lincoln synchronizer. 3400 w. Engr, U. S. A.—Dec. 15, 1903. No. 59608 C.

LIGHTING.

Arc Lamps.

Flame Arc Lamps. J. Zeidler. Extracts from a paper before the Electrotechnische Verein of Berlin, describing two forms of lamp. 1200 w. Aust Min Stand—Nov. 5, 1903. No. 59755 B.

Radiation.

Radiation and Illumination. An outline of the modern aspect of radiation and illumination. 4500 w. Engng—Nov. 20, 1903. Serial. 1st part. No. 59344 A.

Spectroscope.

Electric Lighting and a New Spectroscopic Method (Ueber Elektrodisches Leuchten und eine Neue Spektroskopische Methode). Dr. Werner von Bolton. An examination of the light effects produced in connection with the electrolysis of aqueous solutions. 3000 w. Zeitschr f Elektrochemie—Nov. 19, 1903. No. 59864 D.

Street Lighting.

Street Lighting in Berlin. A Comparison Between Electric Arc Lights and High-Pressure Gas-Burners. Translation of a paper read before the German Assn. of Gas and Water Engrs. Results of photometrical observations conducted by Prof. Drehschmidt. Diagrams. 2200 w. Jour Gas Lgt—Dec. 8, 1903. No. 59717 A.

MEASUREMENT.

Ammeter.

Construction of a Magnetic Vane Voltmeter or Ammeter. J. C. Brocksmith. Working drawings with directions. 1200 w. Am Elect'n—Dec., 1903. No. 59417.

Compensation.

Improvements in Compensation Apparatus (Ueber Neuerungen an Kompensations-Apparaten). Dr. Rudolf Franke. Describing varieties of apparatus for measuring a wide range of pressures. 2000 w. Elektrotech Zeitschr—Nov. 26, 1903. No. 59858 B.

Curve Form.

The Influence of the Curve Form on the Application of the Two-Wattmeter Method (Der Einfluss der Kurvenform bei Anwendung der Zweiwattmetermethode). L. Bloch. A discussion of the methods of measuring the effectiveness of a polyphase current. 2000 w. Elektrotech Zeitschr—Dec. 3, 1903. No. 59861 B.

Dynamo Testing.

Testing Alternators Under Full Load Conditions. W. L. Waters. Criticisms of method recently discussed by Mr. Behrend, showing the results are unreliable in regard to regulation, and are apt to exaggerate the iron losses to the prejudice of efficiency. Also a letter from Mr. Behrend. 1600 w. Elec Wld & Engr—Nov. 28, 1903. No. 59374.

The Testing of Electric Generators by Air Calorimetry. Richard Threlfall. Read before the Inst. of Elec. Engrs., England. An account of experimental investigations of the writer, and this method of testing. Ill. 8800 w. Elect'n, Lond—Nov. 27, 1903. No. 59436 A.

The Testing of Electric Generators by Air Calorimetry. Abstract of the discussion of paper by Prof. R. Threlfall, with editorial. 3500 w. Elect'n, Lond—Dec. 4, 1903. No. 59623 A.

Form Factor.

Measurement of the Form Factor of an Alternating Current. (Die Messung des Formfaktors einer Wechselspannung). P. Rose and A. Kühns. An examination of the relation of the effective to the mean pressure in alternating currents. 2000 w. Elektrotech Zeitschr—Dec. 3, 1903. No. 59860 B.

Meters.

Meter Connections for Three-Wire Systems (Zählerschaltungen für Drehstromnetze mit Nullleiter). Georg Stern. A comparison of the methods of Aron and of the author for the measurements of efficiency in three-phase systems. 1800 w. Elektrotech Zeitschr—Nov. 26, 1903. No. 59857 B.

Strobograph.

The Slow Registration of Rapid Phenomena by Strobographic Methods. E. Hospitalier. Read before the Inst. of Elec. Engrs. Describes wave-recorder and power-recorder instruments. referring to applications. Ill. 7500 w. Elect'n, Lond—Dec. 11, 1903. No. 59725 A.

Wattmeters.

Making an Integrating Wattmeter. Some points in the construction of the Stanley wattmeters with views of the Stanley Instrument Company's works. 2500 w. Elec Rev N. Y.—Dec. 12 1903. No. 59578.

Rating of Wattmeters for Three-Phase Systems. Charles Brandeis. Gives curves devised by the writer and explains their use. 1000 w. Can Engr—Dec., 1903. *No. 59444.*

POWER APPLICATIONS.

Agriculture.

The Application of Electricity to Agricultural Machinery (Les Machines Agricoles et l'Agriculture). E. Guarini. With illustrations of practical applications of electric motors to various agricultural operations. 3000 w. Rev Gen des Sciences—Nov. 30, 1903. No. 59835 D.

Charging Machine.

Improved Machinery for Charging Open Hearth Furnaces (Neuere Chargiermaschine zur Beschickung der Herdöfen in Hüttenwerken). W. Küppers. Describing improved electrically operated machines designed in Germany for operating in connection with overhead travelling cranes. 2500 w. Elektrotech Zeitschr—Dec. 3, 1903. No. 59859 B.

Cranes.

Modern Cranes (Neuere Krane). A. Müller. Illustrating and describing locomotive, bridge and gantry cranes, operated by electric power, recently installed in important workshops in Germany. 2000 w. Zeitschr d Ver Deutscher Ing—Nov. 28, 1903. No. 59813 D.

Electric Vehicles.

See Mechanical Engineering, Automobiles.

Escalator.

Electric Traveling Incline (Rampe Mobile Electrique). René Weil. A description of the double incline escalator between the beach and the bluffs at the watering place of Biarritz, France. 1800 w. 1 plate. Génie Civil—Dec. 12, 1903. No. 59809 D.

Glass Making.

Power Equipment in a Bottle-Making Plant. R. M. Hopkins. Describes the plant and processes used by the Illinois Glass Co., of Alton, Ill., and explains the electrical system employed, the apparatus installed, and the general arrangement of the power plant and transmission system. 2500 w. Eng. Rec—Dec. 12, 1903. No. 59598.

Induction Motors.

The Choice of the Rotor Diameter of Induction Motors. Translation of an article by H. M. Hobart in *Elektrotechnische Zeitschrift.* Emphasizes the importance of that part of the total inductance, which is due to the end connections, and develops a practical method by which the best dimensions may be decided. 1200 w. Elec Engr, Lond—Dec. 11, 1903. No. 59720 A.

Loading.

Load Equalization for Asynchronous Motors (Belastungsausgleich von Asynchronmotoren für Stossweise Betriebe).

Hans Linsenmann. An examination of the influence of irregular loading, developing curves for computation of turning moments, and regulating masses. 2500 w. Elektrotech Zeitschr—Nov. 19, 1903. No. 59853 B.

Machine Driving.

Power for Large Machine Tools. Charles H. Benjamin. An illustrated report of a series of measurements made by the senior students of Case School of Applied Science on electrically-driven machines in two large modern shops. 1500 w. Cassier's Mag—Dec., 1903. No. 59747 B.

Mining Power.

A Central Electric Power Plant of the Coal-Mining Department of the Delaware, Lackawanna & Western Railroad Co. at Scranton. H. M. Warren. Illustrated detailed description. 3300 w. Mines & Min—Dec., 1903. No. 59384 C.

Power Consumption for Mining Machinery (Kraftbedarf von Bergwerksmaschinen). H. Huber. Data and results of tests of electrically driven mining machinery, with fac-simile reproductions of the records of the registering apparatus. 2500 w. 11 plates. Glückauf—Dec. 12, 1903. No. 59850 D.

The Plant of the Richard Mine at Brüx (Die Neue Anlage Richard-Schacht in Brüx). Paul Sonntag. A very complete description of the electric power plant installed in an important coal mine in Northwestern Bohemia. Three articles, 7500 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—Nov. 21, 28, Dec. 5, 1903. No. 59852, each D.

Motor Diagrams.

A Graphical Development of the Ossanna Diagram (Graphische Ermittelung des Ossannaschen Diagrammes). Ad. Thomälen. A comparison of the Ossanna and the Heyland diagrams for induction-motor computations. 4000 w. Elektrotech Zeitschr—Nov. 26, 1903. No. 59856 B.

Peat-Coal.

Peat-Coal by Electrical Process. Description of the apparatus employed and its method of operation, as used by a firm in England. Claims to convert peat into firm, smokeless steam coal at small cost. 800 w. U S Cons Repts, No. 1824—Dec. 12, 1903. No. 59551 D.

Pumps.

Electrically Driven Well Pumps. Illustrated description of a plant installed in London to pump a private well. 1200 w. Engr, Lond—Dec. 18, 1903. No. 59780 A.

Single-Phase.

A Single-Phase Motor. Illustrated description of the motor employed in the new system of single-phase traction introduced by the Union Elektricitäts Gesellschaft. 3000 w. Elect'n, Lond—Nov. 27, 1903. No. 59437 A.

European Single-Phase Railway Motor. Guido Semenza. An illustrated account of experiments with the motor designed by Giorgio Finzi. 3000 w. St Ry Jour—Dec. 12, 1903. No. 59584 C.

Self-Starting Single-Phase Motor without Commutator (Mit-Last Angehender Kollektorloser Einphasen-Wechselstrommotor). Dr. Max Corsepius. Describing a simple form of single-phase motor. 2500 w. Elektrotech Zeitschr—Dec. 10, 1903. No 59863 B.

The Finzi Single-Phase, Alternating-Current Traction Motor. Enrico Bignami. Illustrated detailed description. 2000 w. Elec Rev, N. Y.—Dec. 12, 1903. No. 59580.

Speed Control.

Speed Variation of Continuous-Current-Motors by Shunt-Control. H. M. Hobart. Reviews recent articles relating to methods of speed control, criticising statements made and explaining principles that need attention. 2500 w. Elec Rev, Lond—Dec. 4, 1903. No. 59622 A.

Vibrations.

Methods of Overcoming the Vibrations Caused by Motors. Sherard Cowper-Coles. Illustrations with brief notes on a method of placing or suspending the motors on springs which has been found satisfactory. 300 w. Elec Chem & Met—Nov., 1903. No. 59650 E.

TRANSMISSION.

Transformers.

Some Notes on the Theory and Working of Transformers. W. Rogers. Considers the fundamental principles of the alternate-current transformer, and important phenomena met with in the working. 2400 w. Elec Engr, Lond—Dec. 18, 1903. Serial, 1st part. No. 59767 A.

MISCELLANY.

Designing.

The Design of Direct-Current Machinery. Val. A. Fynn. Confined particularly to the smaller machines, discussing points in design, etc. Ill. 1800 w. Elec Rev, Lond—Nov. 20, 1903. Serial, 1st par. No. 59358 A.

Education.

The Education of an Electrical Engineer. Prof. F. G. Baily. Abstract of a paper read before the Glasgow Local Soc. of the Inst. of Elec. Engineers. Outlining a scheme of education. 1200 w. Elect'n, Lond—Dec. 11, 1903. No. 59724 A.

England.

Some Hindrances to the Development of the Electrical Manufacturing Industry in this country. E. W. Cowan. Chairman's address to Manchester Local Section of the Inst. of Electrical Engineers. Abstract. 3300 w. Elect'n, Lond—Nov. 20, 1903. No. 59357 A.

Gilbert.

Gilbert of Colchester, Father of Electrical Science. A reprint of part of the Chapter on Electrics from *De Magnete*, Lib. II., with notes by Silvanus P. Thompson. Also an account of the Gilbert tercentenary commemoration. 9000 w. Elect'n, Lond—Dec. 11, 1903. No. 59723 A.

Siberia.

Electricity in Siberia. Illustrated article describing electrical installations seen by an American traveler. 1600 w. Elec Rev, N. Y.—Dec. 12, 1903. No. 59581.

GAS WORKS ENGINEERING

Combustion Products.

Combustion Products of Gas and Oil Stoves. Particulars of the experiments made by Dr. Thorpe designed to ascertain the effects of burning gas and oil in heating stoves. Also editorial. 3000 w. Jour of Gas Lgt—Nov. 24, 1903. No. 59421 A.

Enrichment.

The Policy of Gas Enrichment (Illustrated by London Practice). Discussion at Detroit, Mich., of the paper of Arthur Graham, Glasgow. 4000 w. Am Gas Lgt Jour—Dec. 14, 1903. No. 59582.

Eruptions.

Gases Generated Within the Earth by Oils Occasionally Create Eruptions. Relates some instances that have been observed. Ill. 1000 w. Am Gas Lgt Jour—Nov. 30, 1903. No. 59364.

Explosions.

Experiments in Gas Explosions. L. Bairstow. Read before the British Ass'n. An account of experimental investigations. 1600 w. Mech Engr—Nov. 21, 1903. No. 59362 A.

Firing.

Notes on Gaseous Firing. J. F. Smith. Read before the Yorkshire Jr. Gas Assn. An illustrated article giving a historical summary and explainng the changes that go on in the gas producer, the principle and theory of gaseous firing, and the practical working. 7000 w. Jour Gas Lgt—Dec. 15, 1903. No. 59753 A.

Flow.

Flow of Gas in Long Pipes and Under High Pressures. An explanation by H. A. Humphrey for working out the formula for the calculation of the isothermal flow of gas in long pipes. 700 w. Jour of Gas Lgt—Nov. 24, 1903. No. 59420 A.

Gas.

Gas. Thomas D. Miller. An illustrated historical review of the manufacture and development of the gas industry, especially describing the *business in New Orleans*, which was the second gas works built in the United States. 5300 w. Jour Assn of Engng Soc's—Oct., 1903. No. 59574 C.

Gas Engines.

See Mechanical Engineering, Special Motors.

Gasholders.

Rules for the Specification of the Ironwork of Gasholders. The substance of two documents promulgated by a joint committee of the German Gas Assn. and the Union of German Gasholder Makers, with a view of establishing a uniformity of practice. Also editorial. 4600 w. Gas Wld—Nov. 28, 1903. No. 59429 A.

Gas Producers.

Apparatus for Converting Fuel into Heating or Power Gas (Ein Verfahren zur Umsetzung der Brennstoffe in Heiz oder Kraftgas). H. Jahns. Describing an arrangement of gas producers in series, with a corresponding increase in efficiency. 2000 w. Glückauf—Dec. 5, 1903. No. 59849 D.

Gas Engines and Gas Producers (Gazogène et Moteurs à Gaz). A description of the installation of Taylor gas producers and engines at the generating station at Etampes. 1000 w. Génie Civil—Dec. 5, 1903. No. 59807 D.

Improved Down-Draft Gas Producer (Nouveau Gazogène à Flamme Renversée). Jules Deschamps. Describing experiments with a reversed draft producer adapted for by-product recovery, and for use with gas engines. 4000 w. Mem Soc Ing Civ de France—Sept., 1903. No. 59875 G.

Mond Gas-Driven Rolling Mills and Power Plant at the Works of Messrs. Monks, Hall & Co., Ltd., Warrington. Illustrated detailed description of gas plant for supplying power to large works. 3200 w. Ir & Coal Trds Rev—Nov. 27, 1903. No. 59511 A.

New Gas-Producing Plants. Illustrations and descriptions of improved producer gas plants designed by a firm of Manchester, Eng. 2000 w. Engr, Lond—Dec. 11, 1903. No. 59741 A.

Pierson's "Suction" Gas-Producer. An illustrated detailed description of this producer and its action, with a statement of the claims made. 1500 w. Engng—Nov. 20, 1903. No. 59346 A.

Producer Gas in Tramway Service. Illustrates and describes an electric tramway, the current for which is supplied from a generating station driven by power gas. 1500 w. Trac & Trans—Dec., 1903. No. 59632 E.

Gas Works.

New Gas-Works at Shrewsbury. Illustrates and describes features of interest. 2300 w. Gas Wld—Dec. 12, 1903. No. 59714 A.

Some Features of Gas Making and Gas Lighting at Elland. An illustrated article describing progress and improvements. 3400 w. Gas Wld—Dec. 19, 1903. No. 59765 A.

Incandescent Lighting.

Incandescent Street-Lighting. J. F. Tyndall. Read before the South-East of Ireland Gas Assn. A short paper giving the writer's experience, with discussion. 2500 w. Gas Wld—Dec. 5, 1903. No. 59618 A.

I. Why Corporations and Companies Should Undertake Internal Fitting Work. A. E. Mottram. II. Incandescent Lighting and Maintenance. S. Meunier. Also discussion. Two papers read before the Manchester Dist. Inst. of Gas Engrs, and discussed together. 1500 w. Jour Gas Lgt—Dec 1, 1903. No. 59518 A.

Retort Charging.

From Orwell to Coke Heap or Wagon. An illustrated description of West's combined charging and drawing machine, recently installed at Ipswich. Also the coke-conveying plant. 5000 w. Jour Gas Lgt—Dec. 1, 1903. No. 59517 A.

Roofs.

Iron Roofs for Gas-Works. Norton H. Humphrys. An illustrated article describing the treatment given to iron roofing, and the advantages of this form of structure. 2000 w. Jour Gas Lgt—Dec. 8, 1903. No. 59715 A.

Subways.

Subway Systems. R. M. Parkinson. Extracts from the first prize essay in the competition on this subject instituted by the Paviours' Company. Ill. 2600 w. Jour Gas Lgt—Dec. 1, 1903. No. 59519 A.

Transmission.

Gas-Pipe v. Copper—A Defense. C. Alfred Smith. A reply to an article by E Kilburn Scott, written in criticism of a previous paper bv Mr. Smith. 2000 w. Elec Rev, Lond—Dec. 4, 1903. No. 59621 A.

Tynemouth.

Tynemouth Gas-Works, North Shields. A. Clement Hovey. Constructional details and costs of recent extensions (1900-1902), with notes on working results. 11200 w. Gas Engrs' Mag—Nov. 10, 1903. No. 59312 A.

INDUSTRIAL ECONOMY

Address.

The Money Value of Technical Training. James M. Dodge. President's address at meeting of the A. S. M. E. Also editorial. 5000 w. Eng Rec—Dec. 5, 1903. No. 59477.

Apprentices.

An Example of Modern Development of the Apprenticeship System. L. D. Burlingame. Describing the system in successful operation in the shops of the Brown & Sharpe Mfg. Co., at Providence. 3500 w. Engineering Magazine—Jan., 1903. No. 59885 B.

British Revenue.

The Fiscal Problem. Sir Charles Malcolm Kennedy. Traces the adoption of the present fiscal policy and tariff of the United Kingdom, the principal European powers, and the United States; explaining the present commercial, industrial and economic position of these powers, and referring to details related. General discussion. 24000 w. Jour Soc of Arts—Dec. 4, 1903. No. 59633 E.

Commerce.

The Evolution of the Commerce of the World (L'Evolution du Commerce du Monde). M. Bichon. A study of the influence of scientific discovery upon the development of commerce in the nineteenth century. 6000 w. Rev Gen des Sciences—Dec. 15, 1903. No. 59836 D.

Conciliation Board.

A Great Experiment: The Anthracite Conciliation Board. The present article reviews the history of the appointment of this board by the Arbitration Commission, stating its duties. 1500 w. Eng & Min Jour—Dec. 24, 1903. No. 59910.

Education.

A Visit to English and Continental Engineering Schools and Commercial Establishments. Forrest Jones. A report of information gained during seven months spent in visiting foreign educational institutions. 7200 w. Sib Jour of Engng—Dec., 1903. No. 59789 C.

University Education and the Education of the Engineer. William Kent. An interesting discussion of education and its aims, and the writer's views on the best way to educate an engineer. 4500 w. Sib Jour of Engng—Dec., 1903. No. 59790 C.

Labor.

The Open Shop. T. F. Woodlock. Address before the Nat. Civic Fed. in Chicago. Discusses the case of the public in favor of the open shop. 2000 w. Ry Age—Dec. 11, 1903. No. 59593.

The Position of Organized Labor. Samuel Gompers. The second of a series of articles by representatives of both sides of the controversy between labor and capital. 7800 w. Bankers' Mag, N. Y.—Dec., 1903. No. 59554 D.

Miners.

The Condition of Miners in the Ruhr District (Die Lage der Bergarbeiter im Ruhrrevier). A review of the book of Dr. Pieper, showing the wages, cost of living, and general condition of the miners in the coal mining district of the Ruhr. 2500 w. Glückauf—Nov. 28, 1903. No. 59847 D.

Panama.

Payments on Account of the Panama Canal. A discussion of the financial side of this great undertaking. 1600 w. Bankers' Mag, N. Y.—Dec., 1903. No. 59553 D.

Piece Work.

Is Anything the Matter with Piece Work? Frank Richards. A discussion of the merits of "piece work" and of the "premium plan." 2000 w. Trans Am Soc of Mech Engrs No. 01.—Dec., 1903. No. 59315.

Premium System.

The Premium System in Practice. Charles B. Cook. An explanation of the system as used in a factory. 1700 w. Ir Trd Rev—Dec. 3, 1903. No. 59449.

Profit-Sharing.

Profit Sharing and the Premium Plan. Kenneth Falconer. Gives a suggested plan of profit-sharing based on the principles of the premium plan of paying wages. 1800 w. Cassier's Mag.—Dec., 1903. No. 59749 B.

Steel Trade.

The Theory and Practice of Dumping. The first of a series of articles on the dumping of foreign iron and steel in British markets. 4000 w. Ir & Coal Trds Rev—Nov. 27, 1903. Serial. 1st part. No. 59513 A.

Trusts.

The Future of the Trusts. Editorial on the recent changes in the administration of the great industries of the country, reviewing the development of American railways as a close parallel. 1700 w. R R Gaz—Dec. 25, 1903. No. 59924.

MARINE AND NAVAL ENGINEERING

Battleship.

U. S. Battleship Missouri. Lieut.-Com. F. C. Bieg. Description of the vessel, giving report of official trial performance, and illustrations of boiler. 7500 w. Jour Am Soc of Nav Engrs—Nov., 1903. No. 59571 H.

Boilers.

See Mechanical Engineering, Steam Engineering.

Bulkhead Door.

The Stone-Lloyd Bulkhead Door. An illustrated description of an extremely ingenious mechanism, fitted to the imperial mail steamer Deutschland. 1200 w. Engr, Lond—Dec. 4, 1903. No. 59644 A.

Coaling.

Coaling at Sea. A. C. Cunningham. An illustrated description of the Cunningham-Seaton proposed method. 1600 w. Jour Am Soc of Nav Engrs—Nov., 1903. No. 59564 H.

Dry-Docks.

Havana Floating Dry-Dock. Now at Navy Yard, Pensacola, Florida. An illustrated description of this dry-dock with an outline of its eventful history. 1100 w. Marine Engng—Dec., 1903. No. 59506 C.

The Concrete Dry-Dock at Kiel, Germany: Subaqueous Construction by Floating Pneumatic Caisson. An illustrated description of interesting construction work, a new plan being devised to meet the peculiar conditions. The central feature of the work is the use of what is in effect a huge diving bell. 6000 w. Eng News—Dec. 3, 1903. No. 59487.

The U. S. Steel Floating Dry-Dock for Cavite, Philippine Islands. J. S. Shultz. Illustrations showing the characteristic features, with explanation of the method of self-docking. 2000 w. Eng News—Dec. 10, 1903. No. 59525.

Ferryboat.

The Oil-Burning Ferryboat Ramona.

An illustrated detailed description of a fire boat to be used in the harbor of San Diego. 2500 w. Marine Engng.—Dec., 1903. No. 59508 C.

Fire-Boat.

New York City Fire-Boat Abram S. Hewitt. Illustrated detailed description. 2400 w. Naut Gaz—Dec. 10, 1903. No. 59600.

Liner.

The New White Star Liner Baltic. Illustration, with brief description. 500 w. Engr, Lond—Nov. 27, 1903. No. 59427 A.

Marine Engines.

Four-Crank Quadruple-Expansion Engine (Macchine a Quadruplice Espansione con Quattro Manovelle). Salvatore Orlando. A description of the construction and trials of the quadruple-expansion engines of the steamship Umbria, of the *Navegazione Generale Italiana.* 10000 w. 6 plates. Rivista Marittima.—July, 1903. No. 59870 H.

Investigation of the Stresses on Frames of Vertical Steam Engines—As Modified for Marine Engines. John H. Meyer. Mathematical investigations of stresses due to the rolling and pitching of the vessel. 11000 w. Jour Am Soc of Nav Engrs—Nov., 1903. No. 59562 H.

Melville.

Rear-Admiral G. W. Melville, U. S. N., and Applied Science in Construction of the New Fleet. R. H. Thurston. On the influence of Admiral Melville in the creation of the "new navy." 1700 w. Pop Sci M—Dec., 1903. No. 59310 C.

Motor Boats.

Motor Vehicles of the Waterways. Illustrates some of these motor boats, calling attention to points in the construction. 1700 w. Automobile—Dec. 12, 1903. No. 59603.

Nile Boats.

The Passenger Boat Service on the Nile. A résumé of the service carried on, with a sketch of the very earliest and the latest type of boat used. 4000 w. Engr, Lond—Nov. 27, 1903. No. 59424 A.

Petrol Launch.

The Racing Petrol Launch "Durendal." Illustrated description of the boat and her performance. 1500. Auto Jour—Dec. 12, 1903. No. 59712 A.

Propellers.

Direction of Rotation of Screw Propellers (Intorno al Senso della Rotazione dell Eliche). Nino Pecoraro. A discussion of trials in the Italian navy concerning the influence of direction of rotation of propellers on the speed of twin-screw vessels. *8000 w.* 6 plates. Rivista Marittima—*Aug.-Sept.*, 1903. No. 59872 H.

Direction of Rotation of Propellers. Nino Pecoraro. Trans from *Revista Marittima.* A report of experimental investigations of propulsive efficiency, discussing also the experiments of R. E. Froude. 7500 w. Jour Am Soc of Nav Engrs—Nov., 1903. No. 59566 H.

Note on the Direction of Rotation of Propellers on Twin-Screw War Vessels. M. Laubeuf. Trans. from ***Bulletin de L'Association Technique Maritime.*** A discussion of the most efficient arrangement. 2700 w. Jour Am Soc of Nav Engrs—Nov., 1903. No. 59570 H.

Schooner Equipment.

The Steam Equipment of a Modern Schooner. An illustrated description of the auxiliary steam appliances, comprising a boiler used for power and heating purposes, steam winches, for anchor sail. and cargo hoisting, and an outfit of pumps, etc. 1800 w. Mach, N. Y.—Dec., 1903. No. 59407 C.

Shipbuilding.

The Progress of Shipbuilding. Editorial review of the address of Sir William White. 4500 w. Engng—Nov. 20, 1903. No. 59347 A.

Steamer.

A Sectional Steamer for Our Colonial Possessions. Illustrates and describes a vessel of novel construction, designed to meet special requirements. 900 w. Sci Am—Dec. 19, 1903. No. 59708.

The Tyne General Ferry Co.'s Twin-Screw Passenger Steamer "Mona." Brief illustrated description. 700 w. Engng—Dec. 18, 1903. No. 59774 A.

The U. S. S. Cleveland. F. C. Bowers. General description, with illustrations and report of official trial. 10800 w. Jour Am Soc of Nav Engrs—Nov., 1903. No. 59567 H.

Submarine.

The Development of the Submarine in the Direction of Increased Scope. Lieut. John Halligan, Jr. A study of the lake submarine torpedo boat "Protector," with illustrations. 10500 w. Jour Am Soc of Nav Engrs—Nov., 1903. No. 59572 H.

The Submarine Boat "Protector." Illustrated description of this American vessel, and information respecting it. 2000 w. Engr, Lond—Nov. 20, 1903. No. 59352 A.

Turbine Engines.

Report Concerning the Design, Installation, and Operation of the Turbine Engines of S. S. Revolution. Also, Report of Board to Observe and Report Concerning the Efficiency of Turbine Engines. Ill. 4000 w. Jour Am Soc of Nav Engrs—Nov., 1903. No. 59573 H.

Warships.

The British Admiralty and Warship Design. Editorial discussion of the Libertad and Constitucion, designed for the Chilian Navy, but recently purchased by the British Admiralty. 2800 w. Engng —Dec. 11, 1903. No. 59735 A.

The Work of the Oregon During the Spanish-American War. Lieut. C. N. Offley. Reviews the work done below the protective deck during the journey of 14,000 miles, showing the importance of maintaining the motive machinery of battleships in the highest state of efficiency. 7000 w. Jour Am Soc of Nav Engrs—Nov., 1903. No. 59568 H.

MECHANICAL ENGINEERING

AUTOMOBILES.

Accumulator.

The Edison Accumulator for Automobiles. W. Hibbert. Read before the Inst. of Elec. Engrs., England. A favorable report, describing results of observation and experiments. Ill. 6500 w. Elect'n, Lond—Nov. 27, 1903. No. 59434 A.

The Edison Storage Battery (L'Accumulateur Edison). P. Janet. A very complete account of the tests which have been made of the Edison alkaline battery at the *Laboratoire Central d'Electricite* in Paris. 10000 w. Bull Soc Int des Electriciens—Nov., 1903. No. 59873 F.

Alcohol.

See Mechanical Engineering, Special Motors.

British Motors.

Automobiles and Motor Boats. Extracts from an address by S. F. Edge on the conditions and prospects of the British automobile industry. outlining an interesting project in regard to motor boats. 3500 w. U S Cons Repts, No. 1829—Dec. 18, 1903. No. 59656 D.

Care.

How to Keep a Car in Idleness. Directions for the cleaning and care of a car which is to be out of use for several months. 1500 w. Automobile—Nov. 28, 1903. No. 59340.

Construction.

Developments in Automobile Construction. Thomas Clarkson. Read before the British Assn. Discusses details, especially in cars for express or passenger service, the various types of motor and their advantages, etc. Ill. 7500 w. Engng—Dec. 18, 1903. No. 59776 A.

Cycle Shows.

The Annual Cycle Shows.—The National and the Stanley. A brief report of the exhibits, with illustrations. 7000 w. Auto Jour—Nov. 28, 1903. No. 59440 A.

Dust.

The *Dust Problem. Col. R. E. Crompton*, and C. W. S. Crawley. Excerpt from a paper read before the Automobile Club. Gives facts observed during a test, and conclusions reached. 3000 w. Auto Jour—Dec. 5, 1903. No. 59614 A.

Four-Cylinder Car.

The New Four Cylinder Toledo Car. Illustrated description of a 1904 model gasoline touring car. 1800 w. Automobile—Nov. 28, 1903. No. 59341.

Hoods.

Hoods and Canopies. A. J. Wilson. Remarks on the comfort and convenience of these additions to motor vehicles, illustrating some designs. 1800 w. Autocar —Dec. 5, 1903. No. 59612 A.

Motor Car.

The "Gladiator" Motor Car. An illustrated description of the mechanism of this car. 1200 w. Prac Engr—Nov. 27, 1903. No. 59442 A.

Packard Car.

Packard "Model L" Four-Cylinder Car. Illustrated detailed description of a vertical, four-cylinder motor vehicle of entirely new design. 1500 w. Automobile —Dec. 5, 1903. No. 59462.

Paris Show.

Motor Cars in Paris. Illustrates and describes interesting cars on exhibition at the sixth annual exhibition. 2700 w. Engr, Lond—Dec. 18, 1903. Serial. 1st part. No. 59779 A.

The Paris Autocar Show. Preliminary description, with illustrations. 5700 w. Autocar—Dec. 12, 1903. No. 59713 A.

The Paris Autocar Show. An illustrated article giving a general description of the cars and accessories. 14000 w. Autocar—Dec. 19, 1903. No. 59761 A.

Petrol Cars.

The F. I. A. T. Petrol Cars. An illustrated description of these Italian vehicles. 2500 w. Auto Jour—Dec. 5, 1903. No. 59613 A.

The 24-H. P. Bollée Petrol Car. Illustrated detailed description of as nearly a noiseless vehicle as can be expected of one self-propelled. 1700 w. Auto Jour—Dec. 12, 1903. Serial. 1st part. No. 59711 A.

The Vauxhall Light Petrol Car. Illustrated description of an English vehicle, intended to be sold at a moderate price. Of simple construction. 4200 w. Auto Jour—Nov. 21, 1903. Serial. 1st part. No. 59342 A.

Small Engines.

Steam Autocar Notes: Small Steam Engines. J. S. V. Bickford. An illustrated description of experimental designs of the writer, their defects, and difficulties. 4600 w. Engr, Lond—Dec. 4, 1903. No. 59642 A.

Speed Indicator.

The Controller Speed Indicator (Le Controleur Indicateur de Vitesse). J. A. Montpelier. Describing a device for indicating continually the speed of an automobile. 1500 w. L'Electricien—Oct. 31, 1903. No. 59877 B.

Steam Omnibus.

Steam Omnibus for Torquay. Illustrates and describes a steam propelled vehicle for public service. 1000 w. Engr, Lond—Dec. 18, 1903. No. 59783 A.

Tractor.

Military Tractor. An illustrated description of the engine which secured the prize of £1,000 offered by the War-office of England. 2000 w. Engr, Lond—Dec. 18, 1903. No. 59782 A.

Tractor Truck.

Mail Delivery by Tractor Truck, with Use of Old Rolling Stock. Illustrated description of the system of motor traction which is having an eighteen months' test in Philadelphia. 800 w. Automobile—Dec. 19, 1903. No. 59686.

HYDRAULICS.

Current-Meters.

A New Station for the Rating of Current Meters by the U. S. Geological Survey, at Denver, Colorado. M. C. Hinderlider. An illustrated description of a first-class rating station, where meters of all kinds can be accurately rated and their actions under different conditions tested. 1800 w. Eng Rec—Dec. 19, 1903. No. 59672.

Investigations of the Motion of Current Meters (Untersuchungen über die Umlaufbewegung Hydrometrischer Flügel). Dr. M. Schmidt. A study of the action of flowing water upon current meters of the Woltmann mill type, discussing methods of calibration. Two articles. 6000 w. Zeitschr d Ver Deutscher Ing—Nov. 21, Dec. 5, 1903. No. 59811 each D.

Electric Pumps.

See Electrical Engineering, Power Applications.

Flow.

See Mechanical Engineering, Measurement.

Hydraulic Plant.

The Hydraulic Plant for Drawing Steel Shells, at the Imperial Arsenal, Osaka, Japan. Gompei Kuwada. Description of the plant and its equipment. Plan of drawing press. 2000 w. Eng Rec—Nov. 28, 1903. No. 59376.

Pelton Wheels.

The Pelton Wheel for Rolling Mills. Illustrates and describes a remarkable experimental and completely successful departure in rolling-mill practice in a tin mill at Cwm Avon, South Wales. 2500 w. Engr, Lond—Dec. 4, 1903. No. 59643 A.

Pumps.

Air-Lift Pumps. Extracts from a paper by L. Darapsky, on "The Application of Compressed Air to the Raising of Water," published in *Berg und Hüttenmännischen Zeitung*, giving information concerning the history and progress of the air-lift system. Ill. 3500 w. Engr, Lond—Dec. 11, 1903. No. 59,739 A.

Experiments on the Efficiency of Centrifugal Pumps. Thomas E. Stanton. Reviews previous experimental work and describes the apparatus used and experiments made, stating the conclusions reached. Ill. 4800 w. Inst of Mech Engrs—Nov. 20, 1903. No. 59314 D.

Water-Powers.

The Development of Small Water-Powers. Louis Bell. Discusses how to utilize to advantage powers not exceeding 500 h. p. in the water. 3800 w. Am Elect'n—Dec., 1903. No. 59414.

MACHINE WORKS AND FOUNDRIES.

Bearings.

Making a Roller Bearing. Describes new features of construction recently made and the methods of manufacture. Ill. 2700 w. Am Mach—Dec. 3, 1903. No. 59451.

Brakes.

Band Brakes. J. S. V. Bickford. An explanation of what a double-acting band brake is, considering types. Ill. 1400 w. Engr, Lond—Nov. 27, 1903. No. 59425 A.

Brass Furnaces.

Iron Tops for Brass Furnaces. Walter J. May. Suggestions for an improved appliance. Ill. 400 w. Prac Engr—Dec. 18, 1903. No. 59763 A.

Cast Iron.

Malleable Cast Iron. Richard Moldenke. Read at the Milwaukee meeting of the Am. Found. Assn. Discusses the structure, composition, etc., of good malleable iron. 3700 w. Foundry—Dec., 1903. No. 59546.

Chains.

Chain Making. Illustrates and describes the methods used by the American Chain Cable Works, of Troy, New York. 1700 w. Sci Am—Dec. 12, 1903. No. 59532.

Coke.

Estimating the Value of Coke for Foundry Use. Walter J. May. On the testing of coke, and things to be considered in determining the economy. 1200 w. Prac Engr—Dec. 4, 1903. No. 59616 A.

Coloring.

Metal Coloring. W. J. Kaup. On the treatment of copper, brass, iron, and steel to produce color effects. 2800 w. Mach, N. Y.—Dec., 1903. No. 59406 C.

Cranes.

See Electrical Engineering, Power Applications.

Cupolas.

Some Cupola Practice. R. H. Palmer. Illustrates and describes prevailing practice in the management of cupolas. 1700 w. Foundry—Dec., 1903. No. 59547.

Drawings.

A Modern Drawing Office. Joseph Horner. Considers the requirements, giving hints on the filing of drawings and plans, and discusses the equipment of the pattern shop and allied questions. 2400 w. Page's Mag—Dec., 1903. No. 59751 B.

Systematizing Drawing-Office Standards. The first of a series of articles intended to illustrate a method of organized work when engaged upon a general class of engineering work, especially in that connected with stationary steam engine plants. 1200 w. Prac Engr—Dec. 18, 1903. Serial. 1st part. No. 59762 A.

Truing Up Drawing Instruments. Frank B. Kleinhans. Directions for truing the various instruments. 1500 w. Ir Trd Rev—Dec. 3, 1903. No. 59447.

Drop Hammers.

Tests of Drop Hammers by the Compression of Copper Cylinders. Report of a test by Dr. R. H. Thurston to determine the efficiency of roll and crank lift drop hammers. 1500 w. Am Mach—Dec. 24, 1903. No. 59904.

Electric Driving.

See Electrical Engineering, Power Applications.

Furnaces.

Furnaces Suitable for Jewellers' Work, Enamelling, Art Casting, and Other Similar Industries. H. H. Cunynghame. Describes briefly furnaces at present in use and their fuels, especially some furnaces recently invented by the writer. Discussion. 6500 w. Jour Soc of Arts—Dec. 11, 1903. No. 59710 A.

Hardening.

Hardening Special Tools. E. R. Markham. Brief description of some methods found to give good results. 1200 w. Am Mach—Dec. 3, 1903. No. 59454.

Lathes.

Heavy Service Lathe. Illustrated description of a lathe for high-speed cutting, with drawings of the gearing. 800 w. Engr, Lond—Nov. 27, 1903. No. 59426 A.

Heavy Turret Lathe. Illustrates and describes a new design of powerful turret lathe recently manufactured in England. It is suitable for screw-cutting, chucking, boring, and general purposes. 2200 w. Engng—Dec. 4, 1903. No. 59638 A.

Machine Tools.

Railroad Shop Tools. Charles H. Fitch. An illustrated article describing recent improvements due to the use of forging presses and dies. 1500 w. Ry Mas Mech—Dec., 1903. No. 59402.

Reciprocating Machine Tools. Illustrations and descriptions of many types. Special supplement. 15600 w. Engr, Lond—Dec. 11, 1903. No. 59740 A.

Speeds and Gearing of Machine Tools. P. V. Vernon. Read before the Manchester Assn. of Engrs. Indicates a method by which the calculations required may be organized with the practical certainty of obtaining the desired sub-division for any given range and number of speeds. 5000 w. Mech Engr—Nov. 21, 1903. No. 59361 A.

What Are the New Machine Tools to Be? John E. Sweet. Considers machine design, and the capabilities of high-speed steel. 1500 w. Trans Am Soc of Mech Engrs, No. 04.—Dec., 1903. No. 59318.

Management.

Modifying Systems of Management. H. L. Gantt. Gives opinions on methods advocated by Mr. Taylor at the Saratoga meeting. 1300 w. Trans Am Soc of Mech Engrs, No. 014—Dec., 1903. No. 59326.

Mechanism.

A New Mechanism. G. T. Bennett. Illustrated description of a skew linkwork of four pieces having the axes of rotation neither parallel nor concurrent. It offers a simple means of communicating rotation immediately between two crossing shafts by the use of a single connecting rod. 2000 w. Engng—Dec. 4, 1903. No. 59639 A.

Patterns.

Pattern Making. Edward C. Fitz Gerald. Read at meeting of Pittsburg Found. Assn. Considers important points in the constructive side of pattern-making, under the heads of working drawings, selection of material, machining and shaping, assembling and finishing. 2000 w. Ir Age—Dec. 17, 1903. No. 59628.

Pattern Making. J. C. Warne. Read at meeting of Pittsburg Found. Assn. Remarks on wood pattern making, considering materials, machinery, men and patterns. 2700 w. Ir Age—Dec. 17, 1903. No. 59627.

Profiling.

Profiling Fixtures and Formers. C. H. Rowe. Hints regarding fixture design and the cutting of formers. Ill. 1300 w. Am Mach—Dec. 3, 1903. No. 59453.

Punching.

Combined Hydraulic Punching and Shearing Machine. Charles Herzberg. Begins an illustrated, detailed description of a machine built in Austria for the Imperial sea arsenal at Pola. 1800 w. Am Mach—Dec. 17, 1903. Serial. 1st part. No. 59663.

Shaper.

A Shaper Arranged for a Rapid Grooving Operation. Illustration, with brief description. 500 w. Am Mach—Dec. 10, 1903. No. 59510.

Sheet Metal.

The Manufacture of Accurate Sheet Metal Parts in the Sub-Press. Joseph Woodworth. Illustrated description of the sub-press and of the approved methods for constructing dies for it. 1600 w. Ir Trd Rev—Dec. 3, 1903. No. 59448.

Shop Notes.

Making Elevator Buckets with the Steam Hammer—A Special Reaming Machine. S. A. Worcester. Brief illustrated descriptions. 900 w. Am Mach—Dec. 17, 1903. No. 59664.

Shops.

Heating and Ventilating of Foundries and Machine Shops. W. H. Carrier. Abstract of a paper read before the Am. Found. Assn. On the difficulties to be overcome in the successful heating of shops and the adaptation of the fan system. 1800 w. Met Work—Dec. 26, 1903. No. 59793.

Suggestions for Shop Construction. F. A. Scheffler. Describes a novel construction used by the writer. Diagram. .900 w. Trans Am Soc of Mech Engrs, No. 09—Dec., 1903. No. 59321.

See also Railway Engineering. Permanent Way and Buildings.

Steel.

Mistaken Blaming of the Steel. E. R. Markham. Showing that the treatment of the steel, and the proper selection for the purpose, are often at fault. 1200 w. Am Mach—Dec. 3, 1903. No. 59452.

Steel Pipe.

Manufacture of Steel Pipe. An article illustrating and describing the plant and methods of the National Tube Works. 2000 w. Sci Am—Dec. 12, 1903. No. 59530.

Taper Holes.

Taper Holes in Machine Spindles. Frank B. Kleinhans. Illustrates and describes a lathe rigged for performing this operation. 600 w. Am Mach—Dec. 24, 1903. No. 59902.

Taps.

Hardening Taps. E. R. Markham. Gives a description of the method known as pack hardening, as applied to the hardening of taps. 1700 w. Am Mach—Dec. 17, 1903. No. 59667.

Thread Cutting.

Adjustable Die Head and Method for Making Threaders for Use in Same. Joseph M. Stabel. Describes the tools and method used. Ill. 1500 w. Mach, N. Y.—Dec., 1903. No. 59408 C.

Tool Room.

The Modern Tool Room. Fred H. Holz, Jr. Read before the Cincinnati Metal Trds Assn. Suggestions for facilitating work in this department. 1700 w. Ir Trd Rev—Dec. 17, 1903. No. 59685.

Tools.

Tool Making. E. R. Markham. Considers the education of modern successful toolmakers, and discusses cutting speeds, reamers, &c., in the present number. Ill. 4500 w. Mach, N. Y.—Dec., 1903. Serial. 1st part. No. 59404 C.

Tripping Devices.

Trip Hooks and Drop Balls. Ulrich Peters. Illustrated description of tripping devices used in connection with drop weights for breaking up foundry iron, or cracking the skulls from slag ladles, and similar work. 1500 w. Am Mach—Dec. 17, 1903. No. 59665.

Wire and Nails.

Steel Wire and Nail Making. Describes the manufacture as carried on at the Donora Works of the American Steel and Wire Company. Ill. 3000 w. Sci Am—Dec. 12, 1903. No. 59531.

Works.

Modern Work-Shop Design. A. Pringle. The bearing of the class of work upon the design and equipment of shops; the important features, the materials, roofing, &c., are discussed. 5200 w. Can Soc of Civ Engrs, Adv Proof—Dec., 1903. No. 59660 D.

The Works of Messrs. Victor Coates and Co., Limited. Illustrated description. 1600 w. Engng—Dec. 11, 1903. No. 59733 A.

Works' Visits. An illustrated description of the manufacture of electric cables and the preparation of the insulation in the Warrington factory of the St. Helens Cable Co., Ltd. 3000 w. Elec Engr, Lond —Dec. 4, 1903. Serial. 1st part. No. 59620 A.

MATERIALS OF CONSTRUCTION.

Alloys.

Light Aluminum Alloys. Editorial review of a paper by Dr. Joseph W. Richards, read before the Am. Soc. for Test. Mat., with general discussion of the work of other investigators. 1600 w. Engng—Nov. 20, 1903. No. 59348 A.

Analysis.

Some Troubles with Samples of Iron and Coke. George C. Davis. Read before the Phila. Found. Assn. Considers some of the sources from which disputes may arise, and how to avoid such difficulties. 1500 w. Ir Age—Dec. 17, 1903. No. 59624.

Copper.

Some Applications of Copper in Engineering Practice. W. Ed. Storey. Abstract of a paper read before the Manchester Assn. of Engrs. Discusses the qualities most desirable in engineer's work, studying the structure and considering applications and points that make for utility. 2500 w. Prac Engr—Dec. 18, 1903. No. 59764 A.

Fire-Brick.

An Example of the Alteration of Fire-Brick by Furnace Gases. Frank Firmstone. Gives analysis with particulars. 1500 w. Trans Am Inst of Min Engrs—Oct., 1903. No. 59541.

Tool Steel.

Cutting Speeds and Feeds with the New Tool Steels. Oberlin Smith. A summary of practical experience with high-speed steels in the workshop showing their great advantages. 2500 w. Engineering Magazine—Jan., 1903. No. 59889 B.

The Analysis of High-Speed Steel. A brief résumé of the methods of analyzing high-speed steel. 1000 w. Engr, Lond—Dec. 11, 1903. No. 59737 A.

The Analysis of High-Speed Steels. Suggests methods of analysis. 1500 w. Engng—Nov. 20, 1903. No. 59345 A.

MEASUREMENT.

Current Meters.

See Mechanical Engineering, Hydraulics.

Flow.

The Pitot Tube. W. B. Gregory. Calls attention to the use of this instrument in measuring the velocity of fluids. Ill. 6800 w. Trans Am Soc of Mech Engrs, No. 015 —Dec., *1903. No. 59327 C.*

Slide Rules.

Slide Rules for the Machine Shop as a Part of the Taylor System of Management. Carl G. Barth. Explains the slide rule method of solution of various problems. 3800 w. Trans Am Soc of Mech Engrs, No. 013—Dec., 1903. No. 59325.

Testing Apparatus.

Air Motors and Air Hammers. Max H. Wickhorst. Illustrates and describes apparatus and methods used in extensive tests of air-drill motors and air hammers, to determine the air consumption, horsepower, stalling load of motors, number and force of hammer blows, &c. 1600 w. Trans Am Soc of Mech Engrs, No. 02—Dec., 1903. No. 59316.

Testing.

Experiments on the Resistance of Steel Castings (Versuche über die Festigkeitseigenschaften von Stahlguss). C. Bach. Data and results of an extensive and accurate series of tests of the strength of steel castings at ordinary and higher temperatures. Two articles. 10000 w. 3 plates. Zeitschr d Ver Deutscher Ing—Dec. 5, 12, 1903. No. 59815. Each D.

Valve Motion.

The Theory of the Stephenson Link Valve Motion. William N. Barnard. Develops a simple method of analyzing the Stephenson Link Mechanism, which is based largely on that given in Bilgram's Valve Gears. 2400 w. Sib Jour of Engng —Dec., 1903. No. 59791 C.

POWER AND TRANSMISSION.

Air Compressors.

An Improvement in Valve-Motion of Duplex Air Compressors. Sterling H. Bunnell. Illustrates and describes the construction. 1000 w. Trans Am Soc of Mech Engrs. No. 06—Dec., 1903. No. 59320.

Cranes.

One-Hundred-Ton Steel Floating Crane. Lieut. Jos. S. Shultz. Illustration, with description of the pontoon crane at the New York Navy Yard. 1200 w. Eng Rec —Dec. 19, 1903. No. 59671.

Twenty-Ton Breakdown Crane. Illustrated description. 600 w. Engr, Lond—Nov. 20, 1903. No. 59353 A.

See Electrical Engineering, Power Applications.

Factory Traction.

Modern Factory Traction. Clarence J. Messer. On the advantages of a telpherage plant, with information of interest. Ill. 2500 w. Cassier's Mag—Dec., 1903. No. 59748 B.

Power Cost.

Cost of Production of Power from Fuel.

T. L. Miller. Abstracts from the presidential address before the Liverpool Engng Soc. Gives details of cost per h. p. of steam power plants. 1500 w. Mech Engr —Dec. 12, 1903. No. 59718 A.

Rope Transmission.

Some Difficulties of Rope Transmission. Arthur Holmes Morse. Considers difficulties in designing rope-drives, discussing the defects. 5000 w. Harvard Engng Jour —Nov., 1903. No. 59308 C.

The Transmission of Power by Ropes. Edwin Kenyon. Abstract of a paper read before the Staffordshire Iron and Steel Inst. Discusses cost and the applications to practice, systems, &c. 4000 w. Ir & Coal Trds Rev—Nov. 27, 1903. No. 59512 A.

Transmission of Power by Ropes. Explains the English and American systems, discussing factors that favor this method, and points in designing of drives. 1400 w. Min & Sci Pr—Dec. 12, 1903. No. 59692.

St. Louis Exposition.

Power and Machinery at the St. Louis World's Fair. An interesting report of noteworthy engineering features. 3500 w. Ir Age—Dec. 10, 1903. No. 59505.

Steam Shovel.

A Steam Shovel of Novel Design. Illustrated description of a new type of excavating machinery which dispenses with the usual equipment of hoisting engine, drums, chains, clutches, &c. 1000 w. Eng News—Dec. 17, 1903. No. 59702.

Variable Speeds.

Variable Speeds for the Planing Machine. Frank B. Kleinhans. Illustrates and describes methods of obtaining variable speed. 1200 w. Am Mach—Dec. 17, 1903. No. 59666.

SPECIAL MOTORS.

Alcohol.

Alcohol as a Motive Power. From the French of M. O. Boudouard, in *Revue de Chimie Industrielle.* Gives a study of alcohol motors, comparing with gasoline, and the results obtained. 1500 w. Sci Am Sup—Dec. 5, 1903. No. 59481.

Alcohol as a Source of Motive Power (L'Alcohol et la Force Motrice). An examination of the availability of alcohol for use in internal-combustion motors, showing its high efficiency. 2000 w. Revue Technique—Dec. 10, 1903. No. 59832 D.

Gas Engine.

A Compact Gas Engine: Beam Type. C. H. Morgan. Illustrates and describes an engine designed with special reference to the use of blast furnace and producer gases. 2000 w. Trans Am Soc of Mech Engrs, No. 016—Dec., 1903. No. 59328.

A Gas Engine Pumping Station. Illustrates and describes the application of gas engines to pumping in the plant of the Pittsburg Plate Glass Co. 2200 w. Power —Dec., 1903. No. 59502 C.

Blast Furnace Gas Engines at the Lackawanna Steel Company's Plant. An illustrated detailed description of the plant at Buffalo, N. Y., which is the largest gas engine plant yet installed. 2400 w. Power —Dec., 1903. No. 59495 C.

Recent Developments in the Construction and Working of Gas Engines. Prof. D. S. Capper. Honorary member's paper read before the Junior Inst. of Engrs. Reviews the important points in the early history, and shows how recent improvements in construction have in some respects placed it in advance of the steam engine. General discussion. 10000 w. Jour Gas Lgt—Dec. 8, 1903. No. 59716 A.

The Blast-Furnace Gas Engine Plant of the Kladno Iron Works (Hochofengasmaschinen-Anlage im Eisenwerke Kladno). Karl Machacek. Describing the installation and operation of two 500 h.p. engines, with indicator diagrams and data of tests. 4000 w. Zeitschr d Oesterr Ing u Arch Ver—Nov. 20, 1903. No. 59820 D.

The Irregularity of Gas Engine Speeds (Der Ungleichformigkeitsgrad von Gasmotoren mit Aussetzerregelung). Dr. R. Mollier. An examination into the degree of irregularity in speed of gas engines provided with hit-and-miss governors. 1200 w. Zeitschr d Ver Deutscher Ing—Nov. 21, 1903. No. 59812 D.

The Starting of Large Gas Engines. E. W. Roberts. Reviews methods, and devices used in the starting of large gasoline marine engines. Ill. 1700 w. Marine Engng—Dec., 1903. No. 59507 C.

See Also Electrical Engineering, Generating Stations.

Gas Power.

See Gas Works Engineering.

Ignition.

Advance of Ignition and Duration of Explosion (L'Avance à l'Allumage et la Durée des Explosions). J. Petin. An examination of the causes and effects of ignition of the charge in a gas engine before the piston reaches the end of the stroke; showing the relation of advance to speed. 1800 w. Génie Civil—Nov. 14, 1903. No. 59801 D.

Sulphurous Anhydride.

The Pressure Temperature Curve of Sulphurous Anhydride. Edward F. Miller. Gives results of experimental determinations. 1000 w. Trans Am Soc of Mech Engrs. No. 010—Dec., 1903. No. 59322.

STEAM ENGINEERING.

Balancing.

Balancing Marine Engines. A mathematical discussion of the vibratory effects. Ill. 1900 w. Naut Gaz—Dec. 3, 1903. No. 59446.

Blowing Engines.

The Westinghouse Blowing Engine. Illustrated detailed description of the construction. 2700 w. Ir Age—Dec. 3, 1903. No. 59378.

The Westinghouse Blowing-Engine. Illustrated detailed description of a new design of the long cross-head type. 2500 w. Engng—Dec. 11, 1903. No. 59734 A.

Boiler Making.

The Manufacture of the Niclausse Boiler (Die Herstellung der Niclausse Kessel). Friedrich Geiseler. A very fully illustrated account of the special machinery and methods used in making the Niclausse water-tube boiler, both at the works of Willans and Robinson, and of J. & A. Niclausse. 2500 w. Zeitschr d Ver Deutscher Ing—Dec. 12, 1903. No. 59818 D.

Boiler Material.

The Study of Material for Boiler Construction (Beitrag zur Materialkenntnis für den Kesselbau). H. Otto. A comparison of tests taken from various portions of a boiler plate. 2000 w. Stahl u Eisen—Dec. 15, 1903. No. 59841 D.

Boilers.

A Water-Tube Locomotive Boiler. Illustrates and describes the design of J. M. McClellon. 900 w. Loc Engng—Dec., 1903. No. 59394 C.

Boiler Design. H. K. Spencer. The first of a series of articles discussing things to be considered in determining the type of machinery to power a vessel, especially the design of boiler. Ill. 2500 w. Marine Engng—Dec., 1903. Serial. 1st part. No. 59509 C.

Characteristics of the Normand Water-Tube Boiler. Augustin Normand, Jr. Illustrated detailed description. 3000 w. Jour Am Soc of Nav Engrs—Nov., 1903. No. 59565 H.

Notes on the Design of Vertical Boilers. Considers important points in design, the neglect of which often causes defects and sources of trouble. Ill. 3000 w. Mech Engr—Dec 5, 1903. Serial. 1st part. No. 59617 A.

Report of U. S. Naval Officers on Boilers of U. S. S. Maine. 5400 w. Jour Am Soc of Nav Engrs—Nov., 1903. No. 59561 H.

The Niclausse *Boiler*. *Charles* M. Howe. A brief illustrated description of this boiler as designed and built in the United States, with data from official error. 9000 w. Jour Am Soc of Nav Engrs—Nov., 1903. No. 59569 H.

The Water-Tube Boiler in the British Fleet. Archibald S. Hurd. An account of the conditions under which this type of boiler was introduced, with remarks on the virtues of this type, and the future outlook. 3300 w. Sci Am Sup—Nov. 28, 1903. No. 59337.

Water-Tube *vs.* Cylindrical Boilers for Naval Vessels. W. Ledyard Cathcart. Reviews the history of the water-tube boiler in marine service, its efficiency, difficulties met, military value, &c., concluding that its advantages make the use of the cylindrical type a grave military error. 9000 w. Jour Am Soc of Nav Engrs—Nov., 1903. No. 59560 H.

Combustion.

Experiments in Steaming with Low Grade Coals (Verdampfungs-Versuch mit Magerkohle). Results of tests made by the Dortmund Boiler Inspection Association, using ordinary draft and steam blast. 1500 w. Glückauf—Dec. 5, 1903. No. 59848 D.

Condensing.

Condensing Plant for High Vacuum with Limited Water Supply. W. H. Roy. Read before the Manchester Assn. of Engrs. Discusses the best type of cooler and the theory and limits of condensing plant efficiency, especially in relation to high vacuum. 3500 w. Mech Engr—Dec. 12, 1903. Serial. 1st part. No. 59719 A.

Saturated Air Condensers. Statistics of tests comparing the relative efficiency and current expense of a saturated air surface condenser and a standard brass tube condenser. 2000 w. Power—Dec., 1903. No. 59496 C.

Economizers.

An Economizer Discussion. Edwin B. Katte. A basis for discussion of the advisability of installing fuel economizers. Followed by papers by A. H. Blackburn, William Downs, R. D. Tomlinson, J. E. Moulthrop, and general discussion. 11200 w. Pro N Y R R Club—Oct. 16, 1903. No. 59306.

Engine Driving.

Notes on Engine Driving in Electric Light Stations. F. T. Callis. Remarks on the changes in design and building of stationary engines, types, methods of lubrication, starting and stopping, &c. 2000 w. Elec Rev, Lond—Dec. 11, 1903. Serial. 1st part. No. 59727 A.

Engine Tests.

Tests of a Compound Engine Using Superheated Steam. Prof. D. S. Jacobus.

Report of tests made to determine whether the builder's guarantee was fulfilled. 2500 w. Trans Am Soc of Mech Engrs, No. 08—Dec., 1903. No. 59382.

Evaporation.

A Series Distilling Apparatus of High Efficiency. W. F. M. Goss. Illustrates and describes apparatus designed to purify water or other liquids by distillation. 3000 w. Trans Am Soc of Mech Engrs, No. 03—Dec., 1903. No. 59317.

Multiple Effect Evaporators. Reviews an article by M. Sekutowicz, in the Sept. *Bulletin* of La Société des Ingenieurs Civils de France. On the evaporation apparatus employed in French sugar factories, and related subjects. 1800 w. Engr, Lond—Nov. 20, 1903. No. 59350 A.

Researches on the Transmission of Heat (Recherches sur la Transmission de la Chaleur). M. Sekutowicz. A very complete investigation of the action of heat in multiple-effect evaporating apparatus. 15000 w. Mem Soc Ing Civ de France—Sept., 1903. No. 59874 G.

Expansion.

Diagram for Adiabatic Expansion of Steam. Sven S. Ekman. Describes a graphical method of calculating the velocity of steam, expanding adiabatically, &c. 2000 w. Power—Dec., 1903. No. 59500 C.

Feeding Boilers.

Piping for Feed Water and Blow-Offs. C. B. Risley. Discusses methods of feeding, and arrangements for blowing off. 1500 w. Engr, U S A—Dec. 1, 1903. No. 59370 C.

Flywheels

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The Use of Flywheels upon Machine Tools. J. C. Steen. Discusses briefly the application to various classes of machinery. 1500 w. Am Engr & R R Jour—Dec., 1903. No. 59399 C.

Foundation Bolts.

Foundation Bolts for Steam Engines. W. H. Wakeman. Suggestions helpful in the proper setting of engines, illustrating some defects. 1000 w. Elec, N Y—Dec. 16, 1903. Serial. 1st part. No. 59589.

Governor.

The Centrifugal Throttle Governor. Ernest R. Briggs. Illustrates and describes a form of governor much used in *England*. 1600 w. Am Mach—Dec. 17, 1903. No. 59662.

Indicators.

The Development of the Outside Spring Indicator. Robert Grimshaw. Illustrations showing the development, with explanatory notes. 400 w. Power—Dec., 1903. No. 59498 C.

The Testing of Indicator Springs (Prüfung von Indikator federn). H. Staus. An account of the testing work done in the laboratory of the technical high school at Karlsruhe. 1200 w. Zeitschr d Ver Deutscher Ing—Dec. 12, 1903. No. 59819 D.

Leaky Flues.

Leaky Fire Boxes and Tubes. Editorial discussing the causes of this trouble. 1200 w. Loc Engng—Dec., 1903. No. 59396 C.

Mechanical Stokers.

Stokers for Electricity Generating Stations. Albert Gay. Read before the Soc. of Engrs. Considers the essentials of perfect combustion, and various types of mechanical stokers which aim to increase the economy in the raising of steam. Ill. 5000 w. Elect'n, Lond—Dec. 11, 1903. No. 59722 A.

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Power Plant.

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Reversing Engine.

Investigations of a Tandem Double Reversing Engine (Versuchsergebnisse an einer Tandem Zwillingsreversiermaschine). Data and results of tests of a double cylinder rolling-mill engine with the Rottmann valve gear. 1000 w. Stahl u Eisen—Dec. 1, 1903. No. 59839 D.

Slide Valves.

The "Missing Quantity" in Double Slide-valve Gears (Das Fehlerglied bei Doppelschiebersteuerungen). H. Gauhe. An examination of the error in valve motion due to the angularity of the connecting rod. 1000 w. Zeitschr d Ver Deutscher Ing—Dec. 5, 1903. No. 59817 D.

Speed Regulation.

Regulation of Engines for Driving Dynamos (Régulation des Moteurs Appliqués à la Commande des Machines Dynamo-Electriques). R. V. Picou. A discussion of the causes of speed variation in electrical generating sets and the modifications in the governing apparatus devised to improve the regulation. 8000 w. Mem Soc Ing Civ de France—Oct., 1903. No. 59876 G.

Stacks.

Some Experiments with Stacks and Exhaust Pipes. T. H. Symington. From a paper before the Richmond Ry. Club. An account of experimental investigations made and the results. 2500 w. Ry & Engng Rev—Nov. 28, 1903. No. 59450.

Steam.

The Science of Steam Generation. F. J Rowan. An illustrated article considering the many sides of the problem of designing a steam generator, and indicating possible improvements. 8000 w. Cassier's Mag—Dec., 1903. No. 59746 B.

Steam Engines.

Construction and Efficiency of a Fleming Four-Valve Engine Directly Connected to 400 K.W. Generator. Benjamin T. Allen. Describes the general construction of, and the results obtained from a new type of four-valve stationary engine. 2000 w. Trans Am Soc of Mech Engrs, No. 011—Dec., 1903. No. 59323.

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Steam Flow.

The Flow of Steam and Gases through Tubes of Varying Cross Section (Strom-üng von Gasen und Dämpfen durch Rohre mit Veränderlichem Querschnitt). A Stodola. Comments on the investigations of Prof. Lorenz. 1200 w. Zeitschr d ver Deutscher Ing—Dec. 5, 1903. No. 59816 D.

Steam Turbines.

A New Steam Turbine Power Plant. Illustrates and describes the application of the electrical system of power distribution in the shops of the Mexican Cent. Ry. at Aguas Calientes, Mexico. 1300 w. Am Engr & R R Jour—Dec., 1903. No. 59400 C.

New Forms of the Steam Turbine. Robert H. Smith. An examination in detail of the statements of Prof. Dr. Riedler in regard to steam turbines, their design, construction, &c. 3500 w. Engr, Lond—Dec. 18, 1903. Serial. 1st part. No. 59777 A.

Notes on the Steam Turbine. Prof. Homer M. Jaquays. Read before the Canadian Soc. of Civ. Engrs. A review of modern turbines and the general principles of the chief types. Ill. 4800 w. Can Engr—Dec., 1903. No. 59445.

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Steam Turbines in Europe. Emile Guarini. An illustrated report of several installations and their performances. 1500 w. Power—Dec. 1, 1903. No. 59497 C.

Tests of Steam Turbines. Abstracts of the Naval Board reports of the Curtis and Parsons types. 3500 w. Ir Age—Dec. 3, 1903. No. 59379.

The Curtis Steam Turbine. Detailed drawing and description of general features. 2000 w. Elect'n, Lond—Nov. 20, 1903. No. 59354 A.

The Steam Turbine and the Future of Thermal Motor (Les Turbines à Vapeur et l'Avenir des Moteurs Thermiques). A. Stodola. A translation of Stodola's exhaustive discussion of the thermodynamics of the steam turbine from the *Zeitschrift des Vereines Deutscher Ingenieure*. Serial. Part 1. 12000 w. Revue de Mécanique—Nov. 30, 1903. No. 59838 E + F.

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Superheating.

Superheated Steam. F. J. Rowan. Read before the Inst. of Engrs. & Shipbuilders in Scotland. The present paper gives a historical review of investigators and their systems. Ill. 2200 w. Mech Engr—Nov. 28, 1903. Serial. 1st part. No. 59431 A.

The Computation of the Advantages of Superheating (Calcul du Bénéfice Du à la Surchauffe). M. Delaporte. A study of the advantages of superheating considered in connection with the steam engine as an imperfect machine. 5000 w. Revue de Mécanique—Nov. 30, 1903. No. 59837 E + F.

MISCELLANY.

Aeronautics.

Aeronautics in America (L'Aviation en Amerique). O. Chanute. A review of recent progress, with especial reference to the aeroplane experiments of the Wright brothers. 5000 w. Rev Gen des Sciences—Nov. 30, 1903. No. 59834 D.

By Motor Through the Air. Illustrated notes of recent developments in the adaptation of automobile motors to air navigation. 1200 w. Automobile—Nov. 28, 1903. No. 59339.

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The Lebaudy Airship. Illustrated description. 1500 w. Sci Am—Dec. 5, 1903. No. 59480.

The Lebaudy Airship. Photographs, with description of interesting features. 1300 w. Auto Jour—Nov. 21, 1903. No. 59343 A.

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Aluminothermics and Some of Its Applications. An illustrated description of the thermit welding process and some of its applications as given in a lecture by Dr. Goldschmidt before the Columbia Univ. Chem. Soc. 1700 w. Am Elect'n—Dec., 1903. No. 59416.

Aluminothermy (L'Aluminothermie). C. Matignon. A description of the theory and practical applications of the Goldschmidt process of obtaining high temperatures by the combustion of metallic aluminum. 8000 w. Rev Gen des Sciences—Nov. 15, 1903. No. 59833 D.

Mechanical and Metallurgical Applications of Aluminothermics. E. Guarini. An illustrated account of the Goldschmidt process, with numerous examples of its practical applications to rail welding, and repairing of broken parts. 2000 w. Engineering Magazine—Jan., 1904. No. 59888 B.

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Index.

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Kites.

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The Mechanical Laboratory of the Polytechnic School at Zurich (Das Machinenlaboratorium am Eidgenossischen Polytechnikum in Zürich). A very fully illustrated description of the new building and the equipment of the mechanical, hydraulic and electrical laboratories. Six articles. 8000 w. 3 plates. Schweizerische Bauzeitung—Oct. 17, 24, 31, Nov. 14, 21, Dec. 12, 1903. No. 59823. Each B.

The Mechanical Laboratory of the Royal Technical High School of Berlin. Walter Mentz. An illustrated review of the arrangement and working of this laboratory. 5800 w. Jour Am Soc of Nav Engrs—Nov., 1903. No. 59563 H.

Mechanical Plant.

The Mechanical Plant of the Broadway-Maiden Lane Building, New York. Illustrated description of a plant to supply the demands of an 18-story office building. 3000 w. Eng Rec—Dec. 19, 1903. No. 59673.

Operating Costs.

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The Homes of the Great Engineering Societies. H. H. Suplee. A fully illustrated description of the houses of the great national engineering societies. 4000 w. Engineering Magazine—Jan., 1903. No. 59886 B.

Thurston.

Biographical Notice of Robert H. Thurston. William Kent. A memorial number devoted to the life and work of Dr. Thurston. Photograph. 25000 w. Sib Jour of Engng—Nov., 1903. No. 59557 C.

Woodworking.

The Removal and Utilization of Shavings and Sawdust (Evacuation et Utilisation des Copeaux). Paul Razous. Describing various forms of conveyors and exhausters for attachment to woodworking machinery. Two articles. 3500 w. Génie Civil—Dec. 5, 12, 1903. No. 59805. Each D.

MINING AND METALLURGY

COAL AND COKE.

Anthracite.

The Separation of Anthracite Coal from Slate. Guy H. Elmore. Address before the Engrs. Club of Scranton. Suggests applying ore concentration practice to coal washing or separating. 1000 w. Eng & Min Jour—Dec. 17, 1903. No. 59682.

Briquetting.

The Briquetting of Small Coal (Die Herstellung Kleinstückiger Briketts). Dr. Steger. A review of various briquetting processes with especial reference to the utilization of coal slack and fine coal Two articles. 5000 w. Stahl u Eisen—Dec. 1, 1903. No. 59840. Each D.

Canada.

The Coal and Iron Resources and Outlook of Canada. The present article is an introductory review. 2000 w. Ir & Coal Trds Rev—Dec. 4, 1903. Serial. 1st part. No. 59732 A.

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The Magnitude of the Coal Industry. F. E. Saward. Extracts from an address before the Modern Sciences Club of Brooklyn. Considers especially mining and distribution in the United States. 2500 w. Ir Age—Dec. 10, 1903. No. 59503.

Coke Handling.

Recent Coke Handling Machinery (Ueber Neuere Koksofen Beschickungsanlagen). O. Simmersbach. Describing recent installations of conveyors, and handling machinery in France and Germany. 2000 w. 1 plate. Stahl u Eisen—Dec. 15, 1903. No. 59842 D.

Electric Power.

See Electrical Engineering, Power Applications.

Foundry Coke.

See Mechanical Engineering, Machine Works and Foundries.

Kent.

Kent Coal. Report made by Mr. R. Etheridge, the consulting geologist to the consolidated Kent Collieries Corporation, Ltd., on the coal and coal-measure rocks being brought to the surface by the Kind-Chaudron, or new process, adopted for deep shaft and pit sinking. 2400 w. Col Guard—Nov. 27, 1903. No. 59438 A.

Montana.

Some Montana Coal Fields. J. Perry Rowe. A general idea is given of the extent of the bituminous and semi-bituminous coal fields of Montana. 4000 w. Am Geol—Dec., 1903. No. 59311 D.

New Colliery.

New Colliery at Bargoed. Illustrated description of a new colliery in the Rhymney Valley, on the boundary between England and Wales. 1200 w. Col Guard—Dec. 18, 1903. No. 59772 A.

New Zealand.

Westport Coal Company's Mine Creek Colliery. Urquhart Brand Inglis. Illustrations and brief description of colliery, with an outline of the method of getting out the coal. 1100 w. N Z Mines Rec—Oct. 16, 1903. No. 59441 B.

Peat.

See Electrical Engineering, Power Applications.

Preparation.

The Preparation of Coal (Kohlenaufbereitung). Alfred Müller. A discussion of the methods employed in Germany to aid hand picking in the separation of slate, dirt and other impurities from coal. 1800 w. Zeitschr d Ver Deutscher Ing—Nov. 28, 1903. No. 59814 D.

Re-Survey.

The Derbyshire and Nottinghamshire Coal Fields. A report of the re-survey of this field. 3500 w. Col Guard—Nov. 27, 1903. No. 59439 A.

Washing.

Coal Washing by the Stewart System. David T. Blakey. An illustrated description of the apparatus as installed for treating bituminous coal in Alabama. 1500 w. Mines & Min—Dec., 1903. No. 59387 C.

Washing Montana Coal. J. V. Schaefer. An illustrated description of the washing of the Montana Coal & Coke Co., at Aldridge, Park Co., Montana. 1300 w. Mines & Min—Dec, 1903. No. 59388 C.

COPPER.

Electrolytic Refining.

See Electrical Engineering. Electrochemistry.

Impurities.

The Effect of Impurities on Commercial Copper. Ernest A. Lewis. Considers

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the effects of single impurities on copper, with notes on the composition of various kinds of copper. 2200 w. Engng—Dec. 4, 1903. No. 59635 A.

New South Wales.

Mining Fields of New South Wales. F. Danvers Power. Remarks based on observations recently made. Deals with the Great Cobar Copper Works and the Lloyd Copper Company. 2300 w. Aust Min Stand—Nov. 12, 1903. No. 59756 B.

Smelting.

The New Flues and Stack at Anaconda. An illustrated description of new reduction works of the Washoe Copper Company, built to overcome trouble caused by smoke. 2200 w. Eng & Min Jour—Dec. 24, 1903. No. 59912.

GOLD AND SILVER.

Alaska.

The Treadwell Group of Mines, Douglas Island, Alaska. Robert A. Kinzie. History, geology and illustrated detailed description of mines and methods of ore that does not yield an average of more than $2 per ton. 13800 w. Trans Am Inst of Min Engrs—Oct., 1903. No. 59545 D.

Arctic America.

Present Condition of Gold Mining in Arctic America. R. A. F. Penrose, Jr. Describes some of the difficulties found in the northwestern part of North America, the mines, and the Klondike region. Ill. 2000 w. Eng & Min Jour—Nov. 28, 1903. Serial. 1st part. No. 59330.

Australia.

Future Gold Production of Western Australia. Divides the mines into four groups, discussing the future outlook. 4800 w. Aust Min Stand—Nov. 19, 26, 1903. 2 parts. No. 59759 each B.

California.

Rich Gold Mines of Sierra County. George F. Taylor. Begins an illustrated account of a district with a recent yield of $190,000,000 from its placer and quartz mines. 3500 w. Pacific C Min—Dec. 10, 1903. Serial. 1st part. No. 59027.

Colloidal Gold.

Behavior of Red Colloidal Gold Solutions toward the Electric Current and toward Electrolytes. J. C. Blake. Describes experimental investigation. 2500 w. Am Jour of Sci—Dec., 1903. No. 59556 D.

Crushing.

A System of Crushing Rock in Stages by Wet Process and Suggestions as to How This Object Can Best be Achieved. Continued discussion of paper by Edward D. Chester, taken as read. 800 w. Jour Chem, Met & Min Soc of S. Africa—Oct., 1903. No. 59647 E.

Cyaniding.

A System of Handling Sand Mechanically for Cyanide Vats. Charles Butters and Albert F. Crank. Abstract of a paper read before the Inst. of Min. & Met., London. Describes the Virginia City plant for treating sands. 4000 w. Eng & Min Jour—Dec. 5, 1903. No. 59469.

The Cyaniding of Some Silver Ores by Percolation. André P. Griffiths and Frank W. Oldfield. Read before the Inst. of Min. & Met. Describes results obtained in a successfully worked percolation plant in Mexico. 2200 w. Can Min Rev—Nov. 30, 1903. No. 59460 B.

Deep Mines.

Deep Workings at the North Star Mines, California. E. L. Oliver. Describes an interesting shaft sunk 1625 feet to tap the North Star Ledge. 1000 w. Eng & Min Jour—Dec. 17, 1903. No. 59680.

Discovery.

Late Discovery of Gold Near Pratten, Talgia Goldfield. Lionel C. Ball. Gives the history of a discovery in Queensland. 1800 w. Queens Gov Min Jour—Oct. 15, 1903. No. 59418 B.

Gold-Field.

The Clunes Gold-Field (V.) A digest of the report furnished the Victorian Mines Department by William Bradford. 1500 w. Aust Min Stand—Nov. 12, 1903. No. 59757 B.

Laboratory Work.

School Laboratory Work. A Free-Milling Gold-Run. Robert H. Richards and E. E. Bugbee. A report of tests made and the results. 2000 w. Trans Am Inst of Min Engrs—Feb., 1903. No. 59536.

Losses.

Causes of Gold Mill Losses. Discusses the ways in which losses may occur, offering suggestions for correcting the trouble. 1800 w. Min & Sci Pr—Dec. 5, 1903. No. 59606.

Lower California.

The Ybarra Mines of Lower California. Brief illustrated description of this gold mine. 1000 w. Min & Sci Pr—Nov. 28, 1903. No. 59403.

Mexico.

Mexican Metallurgical Methods. A. W. Warwick. The present article gives an illustrated description of the Patio process. 1400 w. Min Rept—Dec. 17, 1903. Serial. 1st part. No. 59688.

Oregon.

Metals and Minerals of Southern Oregon. D. H. Stowell. List of metals and minerals of value found in this district. Gold, silver, and a great variety are found. 700 w. Min Rept—Nov. 26, 1903. No. 59335.

Quartz Veins and Mines of Southern Oregon. Dennis H. Stovall. Considers the causes of the slow development in this region, describing the gold and silver deposits. 900 w. Min & Sci Pr—Dec. 12, 1903. No. 59694.

Ore Treatment.

Treatment of Cassilis Ore. William Aplin. Prize paper. Describes the treatment of these very refractory gold ores. 2800 w. Aust Min Stand—Nov. 5, & 12, 1903. 2 parts. No. 59754. Each B.

Placers.

Geology of the Apache Cañon Placers. 2000 w. Eng & Min Jour—Dec. 24, 1903. No. 59913.

Gold Placers in Bokhara. E. D. Levat. Abstract from *Annales des Mines*. Describes the rich gold deposits of Central Asia. 2200 w. Eng & Min Jour—Dec. 24, 1903. No. 59914.

The Alsek Placer District, Yukon Territory. W. M. Brewer. Map, with information from prospectors' reports. 800 w. Min & Sci Pr—Dec. 5, 1903. No. 59607.

Production.

The Geological Features of the Gold Production of North America. Discussion of the paper of Waldemar Lindgren at the New Haven meeting. 2000 w. Trans Am Inst of Min Engrs—Oct., 1902. No. 59538.

Slimes.

Slimes Process at the Consolidated Mercur Gold Mines. George Moore: An illustrated description of the Moore process fillers in operation. 1200 w. Eng & Min Jour—Dec. 5, 1903. No. 59470.

Thunder Mountain.

Thunder Mountain District, Idaho. A. E. Borthwick. A brief article giving information of this region and reporting a few of the properties in the porphyry belt. 900 w. Min & Sci Pr—Dec. 12, 1903. No. 59693.

Thunder Mountain District. William E. L'Hame. Describes the geological peculiarities and the situation of the various regions of this gold, silver and copper district. 4500 w. Mines & Min—Dec., 1903. No. 59386 C.

Victoria.

The Pyrenees Goldfield (V.) W. Bradford. Describes the topography and deposits. 1500 w. Aust Min Stand—Oct., 22, 1903. No. 59363 B.

Witwatersrand.

The Investigation of Old Mine Workings on the Witwatersrand. T. Lane Carter. An account of some valuable finds and work in progress. 1,300 w. Eng & Min Jour—Dec 17, 1903. No. 59683.

IRON AND STEEL.

Bilbao.

The Iron Ore Industry at Bilbao. Editorial discussion of the situation at these noted Spanish mines, the recent strike, the working, quality, &c. 1500 w. Engng —Dec. 18, 1903. No. 59775 A.

Blast-Furnace Practice.

Hearth-Areas and the Number of Tuyeres in Iron Blast-Furnace Practice. F. L. Grammer. Discusses blast-furnace practice, the means of determining the number of tuyeres required, &c. 3400 w. Trans Am Inst of Min Engrs—Oct., 1903. No. 59537.

Cast Iron.

See Mechanical Engineering, Machine Works and Foundries.

Charging Machine.

See Electrical Engineering, Power Applications.

Electric Smelting.

See Electrical Engineering, Electrochemistry.

Gas Furnaces.

Gas Furnaces for Melting and Heating (Einiges über Gas-Schweissund Wärmöfen). T. Stapf. An examination of the conditions of combustion in gas furnaces, showing their adaptability to metallurgical operations. 6000 w. Stahl u Eisen—Dec. 15, 1903. No. 59843 D.

Guns and Armor.

Gun Steel and Armor Plate. An illustrated description of the plant of the Bethlehem Steel Company and its processes. 3000 w. Sci Am—Dec. 12, 1903. No. 59528.

Ingots.

A New Process for Avoiding Piping in Steel Ingots. From *Stahl und Eisen*. An illustrated account of a process which attempts to reduce the required volume by maintaining a high temperature in the head. 2300 w. Ir & Coal Trds Rev—Dec. 18, 1903. No. 59926 A.

Lapland.

Iron Ores of Arctic Lapland. Chas. S. Osborn. Brief account of iron ore fields beyond the Arctic Circle. 1200 w. Aust Min Stand—Nov. 19, 1903. No. 59758 B.

Rolls.

Notes on the Design of Rolls. Emil Kirchberg. From *Stahl und Eisen*. An illustrated article discussing changes and progress, material, &c. 3800 w. Ir Age —Dec. 10, 1903. No. 59504.

Steel.

See Mechanical Engineering, Machine Works and Foundries.

Steel Rails.

The Manufacture of Steel Rails. An

illustrated description of the Edgar Thomson Works, as representative of the scale of these establishments in the United States, and the methods of labor-saving. 2300 w. Sci Am—Dec. 12, 1903. No. 59527.

Steel Trade.

See Industrial Economy.

Structural Steel.

Manufacture of Bridge and Building Structural Shapes. An illustrated description of the Pencoyd Iron Works as representative of the United States plants and methods. 1500 w. Sci Am—Dec. 12, 1903. No. 59529.

MINING.

Anemometers.

The Anemometer Testing Station of the Westphalian Mining Association at Bochum (Mitteilungen aus der Anemometer-Prüfungsstation der Westfälischen Berggewerkschaftkasse in Bochum). H. Stach. With illustrations of a variety of anemometers used in measuring air currents in mines and the methods used in calibrating them. 4000 w. Glückauf—Nov. 28, 1903. No. 59846 D.

Deep Mining.

The Limits and Possibilities of Deep Mining. E. H. Roberton. A discussion of the problems of temperature, pressure, and deep-winding machinery, and the extent to which they have been solved. 3500 w. Engineering Magazine—Jan., 1903. No. 59887 B.

Electric Power.

See Electrical Engineering, Power Applications.

Explosives.

The Manufacture of Nitro-Glycerine Explosives. William Cullen. Notes explaining the different processes involved. 2300 w. Jour Chem Met & Min Soc of S Africa—Oct., 1903. No. 59645 E.

Milling.

The Ferraris Ball-Mill. Walter Renton Ingalls. An illustrated detailed description of a new device, designed especially for wet crushing, with remarks. 1400 w. Eng & Min Jour—Nov. 28, 1903. No. 59331.

Mine Gases.

Some Mine Gases: Their Toxicology and Possible Connection with Miners' Phthisis. Continued discussion of a paper by A. Heymann. 10000 w. Jour Chem, Met & Min Soc of S Africa—Oct., 1903. No. 59646 E.

Mine Improvements.

The Mineville Magnetite Mines. Illustrates and describes recent improvements of the mining and separating plant of Witherbee, Sherman & Co., Port Henry, N. Y. 8000 w. Ir Age—Dec. 17, 1903. No. 59625.

Miners.

See Industrial Economy.

Ore Bodies.

On the Differentiation of Igneous Magmas and the Formation of Ores. Jas. F. Kemp. A discussion of interest to mining engineers. 2000 w. Eng & Min Jour—Nov. 28, 1903. No. 59329.

Ore-Deposits.

Ore Deposits Near Igneous Contacts. W. L. Austin. A discussion of the paper of Walter Harvey Weed, at the New Haven meeting. 2800 w. Trans Am Inst of Min Engrs—Oct., 1902. No. 59540.

The Chemistry of Ore-Deposition. John A. Church. Discussion of the paper of Walter P. Jenney at the New Haven meeting. 2000 w. Trans Am Inst of Min Engrs—Oct., 1902. No. 59539.

Ore Testing.

Testing Ores by Vanning. Richard Pearce. Illustrates and describes various experiments in concentration by vanning, showing the usefulness of the vanning shovel. 1800 w. Eng & Min Jour—Dec. 24, 1903. No. 59911.

Rope Haulage.

New Endless-Rope Haulage Plant. Erskine Ramsay. Describes the plant at Slope No. 3, Pratt Mines Div., Tennessee Coal, Iron & Railroad Co., in Alabama. 2000 w. Mines & Min—Dec., 1903. No. 59389 C.

Separator.

The Freid Gravity Dry-Process Separator. Douglass McLean. Illustrated description. 800 w. Eng & Min Jour—Dec. 24, 1903. No. 59915.

Shaft Sinking.

Refrigeration in Shaft Sinking. Gives details of a difficult shaft put down in Holland, the machinery and apparatus used. Ill. 3800 w. Ice & Refrig—Dec., 1903 No. 59393 C.

Shafts.

Iron Shaft Fittings with Single Guides (Eiserner Schachtausbau mit Einseitiger Korbführung). F. Schulte. Showing an arrangement of structural iron work to replace the ordinary timbering used in mine shafts. 1800 w. Glückauf—Dec. 12, 1903. No. 59851 D.

Smelting.

Notes and Freehand Sketches Around the Omaha and Grant Lead Smelter at Denver, Colo. Prof. Arthur Lakes. A pictorial description of the principal processes. 2000 w. Mines & Min—Dec., 1903. No. 59390 C.

We supply copies of these articles. See page 796.

Steam Shovels.

Steam Shovels in Mines. George E. Cole. Illustrated description of these machines and their work in the Granby Co.'s ore quarries at Phœnix, B. C. 1500 w. B. C. Min Rec—Dec., 1903. No. 59604 B.

Vanning-Buddle.

The Sperry Vanning-Buddle. Edwin A. Sperry. An illustrated description of the machines, with statement of some of the results obtained. 3000 w. Trans Am. Inst of Min Engrs—Oct., 1903. No. 59542.

Winding.

A Winding Engine Problem. Working out an example to show how simple methods may be used to solve fairly difficult problems of a practical kind when they are properly applied. 2700 w. Engr, Lond—Dec. 11, 1903. No. 59736 A.

Blosfeld's Safety Brake for Winding Engines. Illustrated detailed description of the "Hercules" safety brake. 1500 w. Ir & Coal Trds Rev—Dec. 18, 1903. No. 59925 A.

Safety Appliances for the Prevention of Overwinding. Illustrated description of various types. 2800 w. Col Guard—Dec. 4, 1903. Serial. 1st part. No. 59634 A.

MISCELLANY.

Asphalt.

Asphalt Mining and Refining in the Indian Territory. W. R. Crane. Describes the deposits, methods of prospecting, mining, milling and refining. 3500 w. Eng & Min Jour—Dec. 19, 1903. No. 59681.

Assaying.

The Assay of Zinc-Box Residues from the Cyanide Process. Richard W. Lodge. Describes experiments made at the Massachusetts Institute of Technology. 5000 w. Trans Am Inst of Min Engrs—Oct., 1903. No. 59544.

The Reduction of Lead from Litharge in Preliminary Assays, and the Advantages of an Oxide Slag. E. H. Miller, E. J. Hall and M. J. Falk. A study of this subject, giving conclusions of the tests described. 3000 w. Trans Am Inst of Min Engrs—Oct., 1903. No. 59543.

Cobalt.

Cobalt Mining in New Caledonia. Geo. M. Colvocoresses. Gives the history, formation and working of the ore, and general information. Ill. 2200 w. Eng & Min Jour—Nov. 28, 1903. No. 59333.

Dodge.

Biographical Notice of William Earl Dodge. James Douglas. Especially reviews the influence and interest in mining and metallurgical work. Photograph. 2000 w. Trans Am Inst of Min Engrs—Oct., 1903. No. 59533.

Lead.

Sources of Lead Production in the United States. Walter Renton Ingalls. Gives statistics of value, with brief reports of important districts. 2000 w. Eng & Min Jour—Nov. 28, 1903. No. 59332.

Lesley.

Biographical Notice of J. Peter Lesley. Benjamin Smith Lyman. An account of his life and work. Photograph. 2400 w. Trans Am Inst of Min Engrs—Oct., 1903. No. 59534 C.

Petroleum.

Petroleum (Le Pétrole). M. Lespeo. The first portion of a general study of the production and refining of petroleum in various portions of the earth. Serial. Part 1. 3000 w. Revue Technique—Nov. 25, 1903. No. 59830 D.

Quicksilver.

The Quicksilver Mines of Idria. T. L. Genter. Illustrated description of these mines in Australia, the second largest known. 2000 w. Eng & Min Jour—Dec. 17, 1903. No. 59679.

Tin.

Crow's Nest Tin Deposits. Lionel C. Ball. Report on the geology and workings of deposits in Queensland. 3000 w. Queens Gov Min Jour—Oct. 15, 1903. No. 59419 B.

Zinc.

The Wisconsin Zinc-Fields. Frank Nicholson. An account of the geology of the district, the development, deposits, &c. Ill. 3000 w. Eng & Min Jour—Dec. 5, 1903. No. 59468.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

Train Heating.

Train Heating by Steam and Compressed Air (L'Application Générale du Chauffage des Trains par la Vapeur et L'Air Comprimé Combiné). *M. Lancrenon.* An account of the results obtained on the Eastern Railway of France. 6000 w. 2 plates. Rev Gen des Chem de Fer—Nov., 1903. No. 59879 G.

Train Resistance.

Experiments upon Train Resistance

(Versuche über den Widerstand von Eisenbahnzügen). Rolf Sanzin. A comparison of the results of French, German and Austrian experiments, giving curves representing the mean results. 5000 w. Zeitschr d Oesterr Ing u Arch Ver—Dec. 4, 1903. No. 59821 D.

Train Resistance. C. O. Mailloux. Summarizes the important fundamental laws and discusses their application to train propulsion. 4500 w. Harvard Engng Jour—Nov., 1903. Serial. 1st part. No. 59307 C.

MOTIVE POWER AND EQUIPMENT.

Brake.

The Lipkowski Compressed Air Brake (Frein Automatique à Air Comprimé). F. Barbier. Illustrating and describing a modification of the Westinghouse brake, used in France and Russia. 2000 w. 1 plate. Génie Civil—Dec. 5, 1903. No. 59806.

Breakage.

Breakage of Car Equipment, Past, Present and Future, Cause and Remedy. Charles Waughop. Short paper presenting facts bearing on this subject, followed by discussion. 8000 w. St. Louis Ry Club —Nov. 13, 1903. No. 59555.

Cars.

Chicago Great Western House and Buffet Cars. Illustrates and describes special cars having original features of interest. 800 w. Ry Age—Dec. 18, 1903. No. 59689.

Counterbalancing.

Locomotive Counterbalancing. Review of the paper of R. A. Parke, before the New England R. R. Club, giving formulæ deduced for correctly counterbalancing the locomotives. 2200 w. R R Gaz—Dec. 11, 1903. No. 59520.

Leakage.

Leaky Tubes and Fireboxes. A. Parfitt. A boilermaker's opinion of some causes of trouble, and ways of remedying. 4500 w. Ry & Engng Rev—Dec. 12, 1903. No. 59588.

Train Pipe Leakage. C. C. Farmer. Discusses the causes and methods of preventing, the troubles caused by it, &c. General discussion. 6000 w. W Ry Club —Nov. 17, 1903. No. 59550 C.

Locomotives.

Heavy Freight Locomotive. Illustrates and describes some of the details of construction. 600 w. Am Engr & R R Jour —Dec., 1903. No. 59398 C.

Multi-Cylinder Locomotives. J. F. Gairns. An illustrated review of the world's practice in multi-cylinder simple and compound locomotives. 4000 w. Cassier's Mag—Dec., 1903. Serial. 1st part. No. 59745 B.

Narrow Gauge Locomotives for Heavy Grades and Sharp Curves (Les Locomotives pour Voie Etroite avec Fortes Rampes et Courbes de Faible Rayon). R. Bonnin. Illustrating locomotives of the Fairlie and Mallet types. 2000 w. Revue Technique—Dec. 10, 1903. No. 59831 D.

Six-Wheels Coupled Express Locomotive.—Chemin de Fer de l'Est. Illustrated description. 500 w. Engr, Lond—Dec. 11, 1903. No. 59742 A.

The Constructional Details of Modern Locomotives. Charles S. Lake. The first of a series of illustrated articles dealing with present-day practice. 2000 w. Prac Engr—Dec. 4, 1903. Serial. 1st part. No. 59615 A.

The French Locomotive for the Great Western Railway. Charles Rous-Marten. On the latest engine of the de Glehn compound type—No. 102. Ill. 2500 w. Engr, Lond—Dec. 4, 1903. No. 59641 A.

The New Caledonian Engines. An account of their performance, with cuts illustrating the boiler used. 800 w. Loc Engng—Dec., 1903. No. 59395 C.

The "Santa Fe" Type Tandem Compound. An illustrated description of the 2-10-2 type which has five pairs of drivers, with a pony truck in front and rear. 500 w. Ry Age—Nov. 27, 1903. No. 59366.

The Trend of Locomotive Proportions. Curves and tables, illustrating the trend which proportions have followed, with explanatory notes. 900 w. Ry Mas Mech—Dec., 1903. No. 59401.

Trevithick's Locomotive Experiment in 1808. In regard to a trial of a locomotive in the year 1808, giving extracts from the newspapers of the day. 1300 w. Engr, Lond—Dec. 18, 1903. No. 59778 A.

Staybolts.

Staybolts. H. A. Ferguson. Discusses some of the most frequent causes of staybolt failures, and the means of minimizing the trouble. General discussion follows. 7000 w. W Ry Club—Nov. 17, 1903. No. 59549 C.

Wrecking Outfits.

The New York Central Wrecking Outfits. Illustrated detailed description. 1700 w. R R Gaz—Dec. 4, 1903. No. 59491.

NEW PROJECTS.

Alaska.

Two New Railroads in Alaska. Illustrated description of the Council City and Solomon River line, and the Alaska Central. Map. 1600 w. R R Gaz—Dec. 18, 1903. No. 59705.

Improvements.

The Newark Improvements of the Lackawanna Railroad. An illustrated account of work for eliminating grade crossings and improving alignment and grades. 2500

w. Eng Rec—Dec. 26, 1903. Serial. 1st part. No. 59907.

N. Y. Central R. R.

Electric Traction for the New York Central Railroad. Information concerning the contracts just awarded for the equipment of the lines near New York City with electricity. Also editorial. 2000 w. Elec Wld & Engr—Nov. 28, 1903. No. 59373.

Ogden-Lucin.

Driving Last Spike on the Ogden-Lucin Cut-Off. An illustrated account of the completion of this great engineering work, with facts concerning it. Map. 2000 w. Ry Age—Dec. 11, 1903. No. 59590.

Transandine.

The Transandine Railway. Charles M. Pepper. Discusses the probability of connecting Valparaiso and Buenos Ayres by rail. the conditions, what has been done, and matters related. 2000 w. Ry Age—Dec. 11, 1903. No. 59591.

PERMANENT WAY AND BUILDINGS.

Ballast.

Stone Ballast. E. A. Hermann. Remarks on the tendency to replace ballast formerly used with crushed stone, giving the claims of superiority. 700 w. Eng News—Dec. 17, 1903. No. 59700.

Dynamometer Car.

The Recording Apparatus on the Northern Railway of France (L'Appareil Enregistreur Employé sur le Reseau du Nord.) M. Rossignol. A description of the recording dynamometer car used for investigating the condition of the permanent way on the Northern Railway of France. 4000 w. Rev Gen des Chem de Fer—Dec., 1903. No. 59880 G.

Improvements.

Delaware, Lackawanna & Western Railroad Improvements at Newark and Harrison, N. J. Illustrated detailed description of extensive work of eliminating grade crossings and reducing grades, costing approximately $3,500,000. 2500 w. Ry Age —Dec. 4, 1903. No. 59461.

Wabash Steel-Concrete Construction. An illustrated description of work under way or completed on this line, noting details of interest 1200 w. Ry Age—Dec. 11, 1903. No. 59592.

Lapland.

The Northernmost Railway in the World (Die Nördlichste Eisenbahn der Erde). H. Claus. A description, with maps, of the railway from the iron-ore deposits of Gellivara to Narvik on the Ofoten-Fiord. 2000 w. Glasers Annalen—Dec. 1, 1903. No. 59844 D.

Shops.

McKee's *Rocks Shops of the Pittsburg* & Lake Erie. Illustrated detailed description of this large plant, which represents the most approved modern practice. 4800 w. Ry Age—Dec. 18, 1903. No. 59691.

Railroad Shop Management. William S. Cozad. Discusses in a general way the subject of shop organization and the relation which must exist between the management and the men before putting the shops on a satisfactory piecework basis. 2000 w. Am Engr & R R Jour—Dec., 1903. Serial. 1st part. No. 59397 C.

Signals.

Hall Electro-Gas Normal Danger Signals on the Union Pacific. Illustrated detailed description of an installation in Wyoming. 1200 w. R R Gaz—Dec. 18, 1903. No. 59707.

Signalling at Philippsburg and Easton. An illustrated description of the "all-electric" switch and signal plants at these adjoining places, recently installed on the Lehigh Valley Railroad. 2000 w. R R Gaz—Dec. 11 1903. No. 59521.

Southern Pacific Passenger Station at San Antonio. An illustrated description of a new passenger station in the Mission style of architecture. 600 w. R R Gaz—Dec. 18, 1903. No. 59706.

The Electric Method of Operating Switches and Signals (Les Appareils Electriques pour la Commande des Aiguilles et des Signaux). M. Rodary. A description of the system in use at the Paris terminal of the Paris, Lyons and Mediterranean Railway. 5000 w. Rev Gen des Chem de Fer—Dec., 1903. No. 59881 G.

The Westinghouse Electro-Gas Signal. Illustrated description of a signal in which carbon-dioxide gas, stored in a liquid form in small reservoirs, furnishes the power for the signal motor. 1200 w. Engng—Dec. 4, 1903. No. 59637 A.

Station.

The Washington Union Station. An illustrated description of a fine station, to cost not less than $4,000,000. 2000 w. R R Gaz—Dec. 4, 1903. No. 59489.

Tunnels.

See Civil Engineering, Construction.

TRAFFIC.

Demurrage.

The Doctrine of Demurrage. Editorial discussion of special statutes of different States modifying the general law. 2500 w. R R Gaz—Dec. 11, 1903. No. 59523.

Traffic Associations.

Railway Traffic Associations—Their Origin, Object and Results. C. E. E. Childers. Read before the Traffic Club of Pittsburg. Their aim to secure uniformity, stability and reasonableness of rates. 3000 w. Ry Age—Nov. 27, 1903. No. 59369.

MISCELLANY.

Fire Risks.

Fire Prevention of Railroad Risks. E. D. Sompayrae. Discusses the importance of preventing fires causing loss of railroad property. Cites cases due to carelessness, and suggests steps tending to the elimination of fires. 2300 w. Ry Age—Nov. 27, 1903. No. 59368.

Northern Securities.

The Northern Securities Case Before the United States Supreme Court. Abstracts of briefs and arguments setting forth both sides of the contention. The Government brought the suit upon the charge that the Sherman anti-trust law had been violated. 8500 w. Ry Age—Dec. 18, 1903. No. 59690.

Testing Plant.

The First Bulletin of the Pennsylvania Railroad's Testing Plant at St. Louis. Describes the work to be carried on with the locomotive-testing plant. 4000 w. R R Gaz—Dec. 4, 1903. No. 59490.

STREET AND ELECTRIC RAILWAYS

Alternating Currents.

Electric Traction with Alternating Currents. A. C. Eborall. Read before the Manchester Soc. of the Inst. of Elec. Engrs. Deals with some features incidental to the employment of three-phase currents for railway purposes, considering briefly the subject of single-phase railway motors. 4700 w. Elect'n, Lond—Dec. 18, 1903. Serial. 1st part. No. 59770 A.

Alternating Motors.

Alternating Motors for Railway Service. Louis Bell. Discusses recent designs in new equipment and the advantages of the alternating-current motor. 2000 w. St Ry Jour—Dec. 19, 1903. No. 59697 C.

Brakes.

Brakes for Electric Cars. W. Park. Outlines the principles governing the retardation of a moving car, describing and discussing the merits of the brakes in use, especially electric brakes. 3300 w. Tram & Ry Wld—Dec. 10, 1903. No. 59731 B.

Braking.

Motors as Emergency Brakes. Cale Gough. An explanation of the action that takes place. Ill. 900 w. St Ry Jour—Dec. 5, 1903. No. 59459 C.

Cable Railway.

The Mendel Railway (Die Mendelbahn). E. Strub. An account of the cable traction railway up the Mendel Pass in the Southern Tyrol. An altitude of 852 metres is surmounted with grades of 64 per cent. Three articles. 5000 w. Schweizerische Bauzeitung—Nov. 14, 21, Dec. 5, 1903. No. 59826 each B.

Employees.

The Methods of Handling the Men on the Camden & Suburban Railway. Gives in detail the methods followed and also the system of preparing time-tables, assigning runs, &c. Ill. 4000 w. St Ry Jour—Dec. 12, 1903. No. 59583 C.

Fare Register.

A New Fare Register. Illustrates and describes a device invented by W. I. Ohmer, which contains many new ideas. 2200 w. St Ry Jour—Dec. 12, 1903. No. 59586 C.

High Speed.

The Marienfelde-Zossen High-Speed Electric Railway Trials. Dr. A. Gradenwitz. A description of the road and the mechanism by means of which a speed of more than 130 miles an hour was attained. 4000 w. Engineering Magazine—Jan., 1903. No. 59884 B.

Improvements.

Improvements on a Kentucky System. An illustrated detailed description of recent improvements in the system of the South Covington & Cincinnati Street Ry. Co. 1700 w. St Ry Jour—Dec. 19, 1903. No. 59695 C.

Interrupter.

An Isolator Interrupter (Isolateur Interrupteur). A description of the Giraud device for supporting trolley or other overhead wires in such a manner that the current is cut off in case the wire is broken. 800 w. Génie Civil—Nov. 21, 1903. No. 59803 D.

Interurban.

Interurban Electric Traction Systems—Alternating Current vs. Direct Current. P. M. Lincoln. Read before the Canadian Engrs'. Soc. Discusses the principal advantages of the alternating-current-electric traction over the direct current, comparing the two systems. 6000 w. St Ry Jour—Dec. 12, 1903. No. 59587 C.

New Interurban Railway in Switzerland. Henri Somach. Brief illustrated description of the line between Wetzikon and Meilen. 800 w. St Ry Jour—Dec. 26, 1903. No. 59918 C.

Ipswich.

The Electric Tramways of Ipswich.

Illustrated description of a new tramway system, the peculiarities are the great size of the power station buildings compared with present requirements, and the use of double-track in narrow streets. 3500 w. Tram & Ry Wld—Dec. 10, 1903. No. 59728 B.

Japan.

The Elevated Railway of Tokio (Die Hochbahn von Tokio). F. Baltzer. A very full account of the construction and equipment of the elevated railway in Tokio, Japan. Serial. 1st part. 4000 w. Zeitschr d Ver Deutscher Ing—Nov. 21, 1903. No. 59810 D.

Light Railway.

The Portsdown and Horndean Light Railway. John R. Hewett. Illustrated description of an English electric line, running from a large town into a rural district. 3600 w. Trac & Trans—Dec., 1903. No. 59631 E.

Mountain Railways.

Mountain Climbing Railways. George E. Walsh. Briefly considers the railways of Mt. Washington, Pike's Peak, Mt. Pilatus, and the Jungfrau. 2400 w. Elec Rev, N. Y.—Dec. 26, 1903. No. 59917.

Multiple Supply.

The Multiple Supply Electric Railway System for Heavy Traffic. W. N. Stewart. On the Edison storage battery and its application to railway trains. 1500 w. Tram & Ry Wld—Dec. 10, 1903. No. 59730 B.

Multiple-Unit.

The Siemens-Schückert Multiple Unit System of Electric Train Control. Emile Guarini. Illustrated article explaining a mixed system in which electricity serves only for the operation of compressed-air valves. 1400 w. Elec Rev, N. Y.—Dec. 19, 1903. No. 59677.

Paris-Versailles.

The Paris-Versailles Electric Railway. Daniel Bellet. An illustrated detailed description of the new route, Invalides-Versailles, its construction, equipment, &c. 5800 w. Trac & Trans—Dec., 1903. No. 59630 E.

Pittsburg.

I. Notes on Rapid Transit with Special Reference to Pittsburg. Emil Swensson. II. The Effect of Multiple Control on the Traction Problem of Pittsburg. N. W. Storer. Two papers discussed together. 17800 w. Pro Engrs' Soc of W Penn—Nov., 1903. No. 59792 D.

Railway Motors.

The Electric Motor as a Railway Motor (Der Elektromotor als Eisenbahnmotor). J. Szasz. A comparison of the relative advantages of continuous and single-phase motors for railway service. 1800 w. Zeitschr f Elektrotech—Nov. 22, 1903. No. 59865 D.

Records.

Daily Reports, Store Room Accounting and Operating Records of the Camden & Suburban Railway. Gives interesting blanks used and explains the system. 3800 w. St. Ry Jour—Dec. 19, 1903. No. 59696 C.

Repairs.

Repair Shop Practice on the Camden & Suburban Road. Illustrates and describes the shops and explains the system in use. 2200 w. St Ry Jour—Dec. 26, 1903. No. 59919 C.

Signals.

Alternating Current for Signaling on Interurban Electric Railways. An account of the demonstrations at Rochester, N. Y., of the automatic block signaling system of S. Marsh Young. Ill. 3000 w. St Ry Jour—Dec. 26, 1903. No. 59921 C.

A Track Circuit Block Signal for Electric Railways. Describes a system recently demonstrated at Rochester, N. Y. 2000 w. Eng News—Dec. 24, 1903. No. 59797.

Single-Phase.

Application of Single-Phase Alternating-Current for Traction and Railway Service. B. G. Lamme. Discusses the commutator type of single-phase motors and their advantages. Also editorial. 6700 w. St Ry Jour—Dec. 26, 1903. No. 59920 C.

The Winter Eichberg Single-Phase Railway System. Illustrates and describes some of the features of this motor as given in the English patent, with remarks on the system. 1100 w. Elec Wld & Eng—Dec. 19, 1903. No. 59698.

South Africa.

Durban (S. Africa) Electric Light and Tramways. Illustrated description of the new combined power plant which is to supply this seaport of Natal. 2000 w. Elec Rev, Lond—Dec. 11, 1903. Serial. 1st part. No. 59752 A.

Stray Currents.

Investigations of Stray Currents in the Street Railways of Geneva (Untersuchungen über Vagabundierende Ströme auf den Strassenbahnen in Genf). L. Thormann. An examination of the electrolytic corrosion of buried pipes by the action of stray currents from the electric tramways. 2000 w. Schweizerische Bauzeitung—Nov. 28, 1903. No. 59827 B.

Train Control.

Electric Train-Control Systems (Elektrische Zugsteuerungen). Dr. F. Niethammer. Discussing the multiple-unit systems of Siemens & Halske, Sprague, Westinghouse, Schuckert, and others. Two articles. 6000 w. Zeitschr f Elektrotech—Dec. 6, 13, 1903. No. 59869. Each D.

EXPLANATORY NOTE—THE ENGINEERING INDEX.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* Boston.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Jl. of Science. *m.* New Haven, U.S.A.
American Machinist. *w.* New York
American Shipbuilder. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. d Ing e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *qr.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Sydney.
Autocar. *w.* Coventry, England.
Automobile. *m.* New York.
Automobile Magazine. *m.* New York.
Automotor & Horseless Vehicle Jl. *m.* London.
Beton und Eisen. *qr.* Vienna.
Brick Builder. *m.* Boston.
British Architect. *w.* London.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bulletin American Iron and Steel Asso. *w.* Philadelphia, U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. Soc. Int. d Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Montreal.
Canadian Mining Review. *m.* Ottawa.
Cassier's Magazine. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Electrical Engineer. *w.* London.
Electrical Review. *w.* London.

Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Electrochemical Industry. *m.* New York.
Electrochemist and Metallurgist. *w.* London.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Chicago.
Engineering. *w.* London.
Enginering and Mining Journal. *w.* New York.
Enginering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penna. *m.* Pittsburg, U.S.A.
Feilden's Magazine. *m.* London.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland, U. S. A.
Gas Engineers' Mag. *m.* Birmingham.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e. d. Str. Ferr. *w.* Rome.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Ice and Refrigeration. *m.* New York.
Ill. Zeitschr. f. Klein u. Strassenbahnen. *s-m.* Berlin.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron and Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. Am. Foundrymen's Assoc. *m.* New York.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Journal of Sanitary Institute. *qr.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery *b-m.* Fort Monroe, U.S.A.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U.S.A.
Locomotive. *m.* Hartford, U. S. A.
Locomotive Engineering. *m.* New York.
Machinery. *m.* London.
Machinery. *m.* New York.
Madrid Cientifico. *t-m.* Madrid.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Metallographist. *qr.* Boston.
Metal Worker. *w.* New York.
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* City of Mexico.
Minerva. *w.* Rome.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci Press. *w.* San Francisco.
Mining Reporter. *w.* Denver, U. S. A.
Mitt. aus d Kgl Tech. Versuchsanst. Berlin.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Modern Machinery. m. Chicago.
Monatsschr. d Württ. Ver. f. Baukunde. *m.* Stuttgart.
Moniteur Industriel. *w.* Paris.
Mouvement Maritime. *w.* Brussels.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *m.* New York.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Nineteenth Century. *m.* London.
North American Review. *m.* New York.
Oest. Wochenschr. f. d. Oeff Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg- & Hüttenwesen. *w.* Vienna.
Ores and Metals. *w.* Denver, U. S. A.
Pacific Coast Miner. *w.* San Francisco.
Page's Magazine. *m.* London.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Procedings Engineers' Club. *qr.* Philadelphia.
Pro. St. Louis R'Way Club. *m.* St. Louis, U. S. A.
Progressive Age. *s-m.* New York.
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago
Review of Reviews. *m.* London & New York.
Revista d Obras. Pub. *w.* Madrid.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Gen. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Engng. *m.* Ithaca, N. Y.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens' Institute Indicator. *qr.* Hoboken. U.S.A.
Stone. *m.* New York.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago.
Tijds. v h Kljk. Inst. v Ing. *qr.* Hague.
Traction and Transmission. *m.* London.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining. Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
Wiener Bauindustrie Zeitung. *w.* Vienna.
World's Work. *m.* New York.
Yacht. *w.* Paris.
Zeitschr. d. Mitteleurop. Motorwagen Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a S.
Zeitschr. f. Electrotechnik. *w.* Vienna.

CURRENT RECORD OF NEW BOOKS

Note—Our readers may order through us any book here mentioned, remitting the publisher's price as given in each notice. Checks, Drafts, and Post Office Orders, home and foreign, should be made payable to THE ENGINEERING MAGAZINE.

Commutators.

Commutator Construction. By William Baxter, Jr. Size, 8 by 5½ in.; pp. 23; figures, 39. Price (paper), 25 cents. New York: The Derry-Collard Co.

The commutator is only a small part of a dynamo or motor, but if it is not well made it may disorganize the whole machine, and its careful construction becomes, therefore, of the greatest importance. In this little book, which is the third number of a series of papers published by the Derry-Collard Co., there is much plain and practical advice on the construction and the repair of commutators. The illustrations are clear, and the pamphlet, which is attractive in appearance, will prove instructive and useful to those who are concerned with the making and the maintenance of a vital part of all direct-current electrical machines.

Electrical Engineering.

Electrical Engineering, An Elementary Text-Book Suitable for Persons Employed in the Mechanical and Electrical Engineering Trades, for Elementary Students of Electrical Engineering, and for All Who Wish to Acquire a Knowledge of the Chief Principles and Practice of the Subject. By E. Rosenberg. Translated from the German by W. W. Haldane Gee and Carl Kinsbrunner. Size, 9¼ by 6 in.; pp. xiii, 267; figures, 263. Price, $1.50. New York: John Wiley & Sons. London: Harper Brothers.

At this late day, a new book on elementary electrical engineering must have some decidedly strong features to justify its publication, and to enable it to prove a useful addition to the mass of such literature. These useful qualities the present work possesses, partly on account of the way in which it originated and partly owing to the manner in which it has been carried out. The book had its origin in a number of lectures delivered by the author to the workmen and the staff of a large electrical manufacturing firm, and follows the general lines of these addresses. It is, therefore, in plain and simple style, and very little, if any, mathematics is required for its understanding. It is also the work of an electrical engineer engaged in active manufacturing operations, and is written from an engineering standpoint. After laying down the fundamental principles of electric currents and magnetism, the description of electrical apparatus is begun, and the various branches of "heavy-current" electrical engineering are taken up. The treatment of alternating currents and alternating-current apparatus, both single- and polyphase, is especially full for a work of this kind, and at the same time is remarkably direct and clear. Among the subjects discussed in the different chapters are the continuous-current dynamo, the electric motor, accumulators, the working of dynamos in parallel, electric lighting, alternating currents, alternators, alternating-current motors, polyphase alternating currents, and high-tension currents. The books is very well and intelligently translated, and is clearly illustrated, and it will undoubtedly prove very helpful to students of electrical engineering and electrical workmen in particular, and to seekers after an understanding of electrical engineering in general.

Electric Railways.

Notes on Electric Railway Economics and Preliminary Engineering. By W. C. Gotshall. Size, 9 by 6 in.; pp. v, 251; many illustrations and diagrams. Price, $2. New York: McGraw Publishing Co.

The purpose of this book is to consider the subject of interurban electric railroading, "broadly and as a whole, to outline the work of the electric railway engineer during the inaugurative and constructive period of a proposed road, and to give in a general way some bases upon which the costs of construction, probable present and future traffic, and ultimate economic results of the proposed railway can be gauged." The book is based upon a series of lectures delivered at Lehigh University, the lecture notes having been filled out and rearranged so that the topics treated follow the order in which they would be taken up in the actual investigation and construction of an electric railway. After the introduction, the chapters are devoted, respectively, to preliminary office determinations; preliminary field survey; detailed office investigations of track location; preliminary determination of schedules and equipment; estimate of earnings;

estimate of probable operating expenses; the final survey; track construction; overhead or third-rail construction; the power station; storage batteries; rolling stock and motors; securing rights of way; preparation of the specifications; the construction period; organization of the operating department; and economic considerations. An appendix contains a set of complete specifications for the construction and equipment of a moderate-sized, high-speed, interurban electric railway, and another appendix contains a list of some articles on interurban electric railway work which have appeared in technical journals. Throughout the book, particular emphasis is laid upon the commercial and financial aspects of electric railways, although the engineering features are by no means lost sight of. The author states that "the controlling features required for the success of high-speed interurban railways in the order of their importance are: First, safety to the public and the employees of the railroad; second, reliability of operation; third, convenience and comfort of the public; fourth, minimum cost of operation and maintenance." In developing his subject, the author draws largely upon his extensive practical experience, and, in particular, liberal use is made of the data obtained in the construction of the New York and Port Chester Railroad, of which he is president and chief engineer. Altogether the work contains a very common sense and practical treatment of a most important subject, and will be of great value to anyone interested in electrical railways, either from the financial or the engineering standpoint.

Electrochemistry.

Kalender für Elektrochemiker sowie Technische Chemiker und Physiker. 1904. By Dr. A. Neuburger. Size, 6¼ by 4¼ in.; pp. xxxv, 575 (supplement, pp. 416); many figures. Price, $1.25. Berlin: M. Krayn.

Electrochemistry is already such an important science, as well as industry, touching, as it does, so many fields of technical activity, and is making such rapid advances, that there is abundant justification for the publication of an annual handbook such as the present work. This is the eighth year of its issue, and it has grown so that a supplementary volume, nearly as large as the original, is necessary to hold the abundant and varied contents. While similar in general appearance and arrangement to the 1903 edition, the present issue has been revised and brought up to date and new matter has been added, among which may be noticed descriptions of the Edison and the Jungner accumulators and a compilation of practically all the better known electro-metallurgical processes for the preparation of steel direct from the ore. The work is far more than a calendar, as it contains a great many tables, illustrations and descriptions of both laboratory and manufacturing processes, the patent laws of many countries, and a great quantity of electrical, chemical and physical data which make it a handy encyclopedia of electrochemistry and its allied industries.

Machine Design.

Machine Design. Part I: Fastenings. By William Ledyard Cathcart. Size, 9½ by 6 inches; pp. xi, 291; figures, 122. Price, $3. New York: D. Van Nostrand Company.

Machine design has been the subject of some able treatises, but as the art is continually advancing, there is need, from time to time, for new works on it, which will record and discuss the latest improvements. Such is the function of the present book, which is concerned particularly with modern American practice in the branch of machine design indicated by the title. The theoretical treatment of the subject has been given fully, and in some cases it is shown how formulae, which are merely stated in the older treatises, are derived. The principal part of this work, however, is its account of the practical developments that have recently taken place, with its discussion of the resulting data. The book is divided into the following parts: Shrinkage and pressure joints; screw fastenings; riveted joints, theory and formulae; riveted joints, tests and data from practice; keyed joints and pin joints. In the chapter on screws, all the standard threads in the United States, in Great Britain and on the Continent of Europe, are fully described, and formulae and tables of them are given. Throughout the book there are many tables and various eminent authorities are cited; there is an index, and altogether the work is a very interesting contribution to the science and the art of machine design, and will be of great value to the student and the designer.

Mechanical Engineering.

The Mechanical Engineer's Reference Book. A Hand-Book of Tables, Formulas and Methods for Engineers, Students and Draftsmen. By Henry Harrison Suplee, B. Sc., M. E. Size, 6¾ by 4¼ in.; pp. xii, 830; fully illustrated. Price, $5 (with thumb index, $5.50). Philadelphia and London: J. B. Lippincott Company.

In most of the engineering hand-books that have been published, a mass of data and a variety of rules are given, and the reader is left to make his own choice, but in this volume, while the principal authorities are quoted, the best rule or formula for a given case is pointed out, or directions are given so that the seeker for information can make an intelligent selection. The field of engineering has widened so greatly that it is impossible to condense all the information essential for engineers in general within the limits of a hand-book or pocket-book, so that a book of this kind must necessarily be confined to one branch of engineering, but the present work, while its specialty is mechanical engineering, also gives valuable tables and data concerning some of the allied branches, such as electrical and marine engineering. The volume is intended to be a successor to the well-known pocket-book written many years ago by the late John W. Nystrom, but the latter's work has served principally as a foundation for a most modern and up-to-date structure. The early tables have been carefully overhauled and many new ones have been added, among the latter being what is probably the first one published for finding the exact perimeter of an ellipse. The metric system receives due recognition, some of the tables—notably those on the properties of steam—being given in both the English and the metric systems, each complete in itself and both in the same form, so that comparisons may be made conveniently. The latest as well as the best authorities have been freely drawn upon, and the results of the most recent investigations have been used in the preparation of this book, so that the engineer who consults it need have no fear of being behind the times. A complete index makes the finding of information easy, and in material and workmanship the book leaves nothing to be desired, being convenient in size, well and attractively bound, and clearly printed on good paper.

Mill Buildings.

The Design of Steel Mill Buildings and the Calculation of Stresses in Framed Structures. By Milo S. Ketchum, C. E. Size, 9 by 6½ in.; pp. xiii, 367; figures, 185. Price, $4. New York: The Engineering News Publishing Co.

Mill, or shop, buildings have become such an important class of framed structures that there is ample room for a treatise on their design and construction. Such is the purpose of the present book, which describes the different kinds of steel mill buildings in common use and goes into the details of their construction. Closely interwoven with the main subject is the calculation of stresses in framed structures, which receives a systematic and adequate treatment. Both the algebraic and the graphic methods of calculating stresses are fully described and illustrated. Each step in the solution is explained and analyzed so that the reader will get a definite idea of the underlying principles. In the discussion of mill buildings, the methods of construction and the materials used are described, together with the design of the structures and the making of estimates of weight and cost. Methods, data and details not ordinarily available are given, and the matter is presented in a way to assist the engineer in making his designs and the detailer in developing them in the drawing room. The author is guided by his experience both as a designing engineer and contracting agent and as a professor of civil engineering at the University of Illinois, so that the book is thoroughly practical and at the same time presents its subject in a systematic and orderly manner, with due attention to fundamental principles. It will, therefore, be of great value both to the designing engineer and to the engineering student.

Space Telegraphy.

Wireless Telegraphy; Its Origins, Development, Inventions and Apparatus. By Charles Henry Sewall. Size, 8½ by 5¾ in.; pp. 229; diagrams and illustrations, 85. Price, $2. New York: D. Van Nostrand Company.

Space, or wireless, telegraphy, although a young art, is growing very rapidly, as it possesses a peculiar fascination for the engineer and inventor, and appeals powerfully to the imagination of the general public. Patent offices are crowded with applications, and although only a small part of the new devices have been tried on a commercially practical scale, the valuable work already accomplished in the domain of wireless telegraphy and the great interest shown in it assure the art a bright, and probably a brilliant, future. At this stage, where there has already been so much individual effort and where so many "systems" are in the field, it is of special importance to have the fundamental principles laid down and to have the various devices analyzed and classified. Such is the aim of the present work, and although the arrangement and systematized treatment of the material leaves something to be desired, which is partly due to the inherent difficulty of the subject, the book contains a large amount of valuable and interesting matter. There is a general history of wireless telegraphy, with particular accounts of the work of the men who have been chiefly instrumental in advancing the art. The leading inventions are described, and the principal patents are examined and analyzed, some of the chief claims and a few of the most important specifications being given in full.

BOOK RECEIVED.

Experimental Researches on Reinforced Concrete. By Armand Considère. Translated and arranged by Leon S. Moisseiff, C. E. Price, $2. New York: McGraw Publishing Co.

THE ENGINEERING MAGAZINE.

MARCH, 1904.

LABOR SAVING BY POWER APPLICATIONS.

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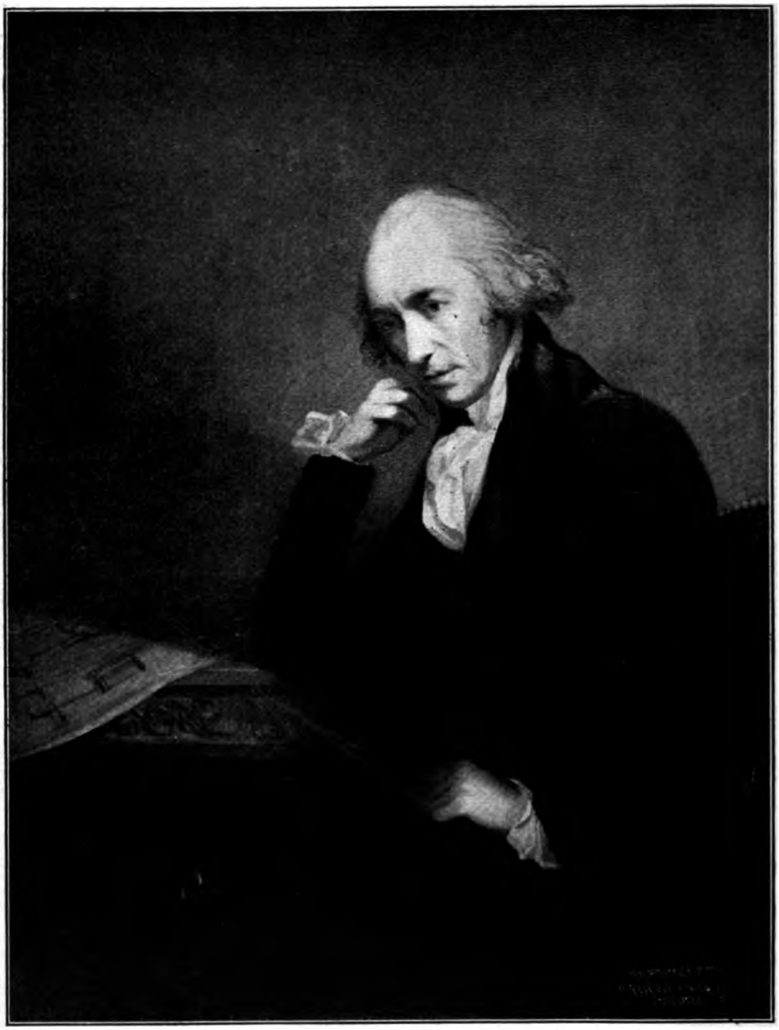

JAMES WATT. 1736-1819.

Portrait by de Breda, National Portrait Gallery. Copyright by Walker & Cockerell.

The great engineer who, "directing the force of an original genius, early exercised in philosophical research, to the improvement of the steam engine, enlarged the resources of his country, increased the power of man, and rose to an eminent place among the most illustrious followers of science, and the real benefactors of the world."—*Lord Brougham.*

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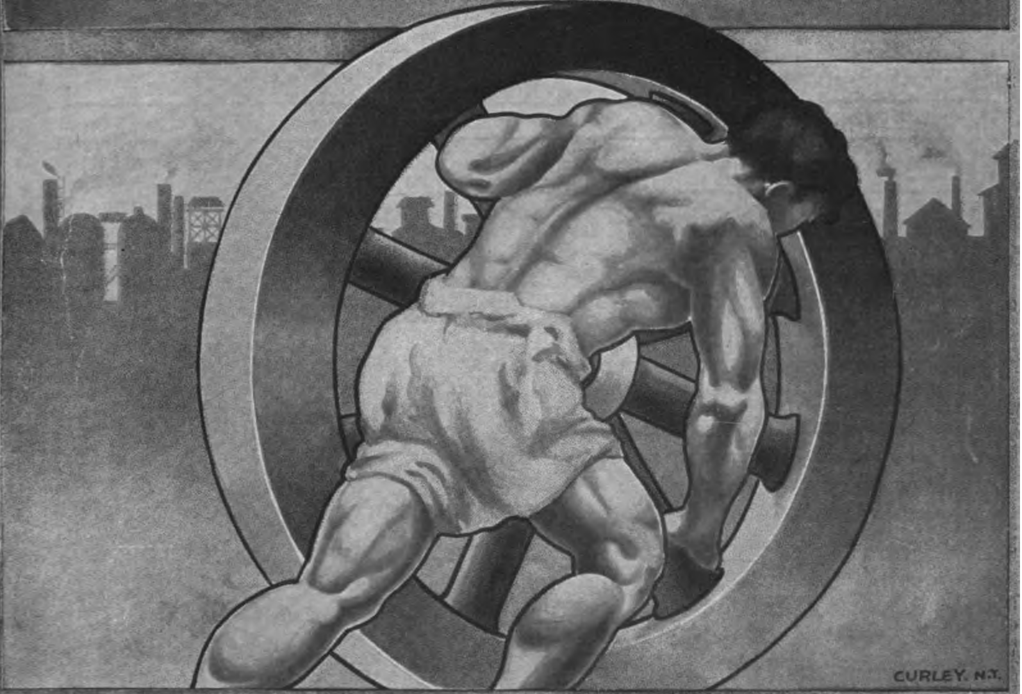
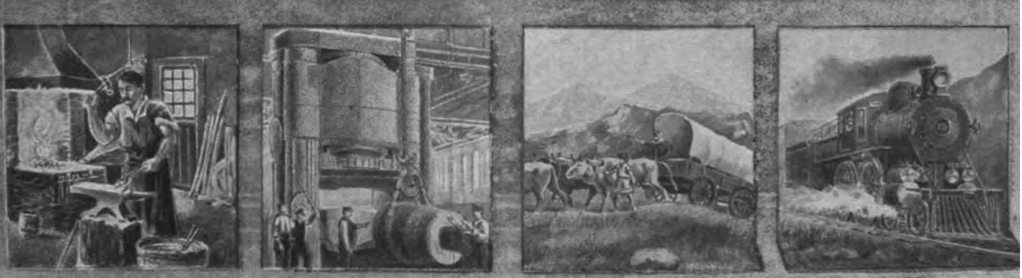
THE ENGINEERING MAGAZINE

AN INDUSTRIAL REVIEW





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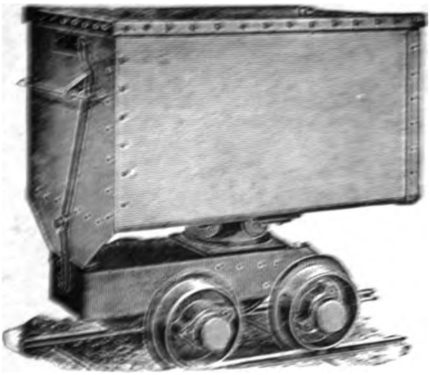

MINE CARS, ORE CARS.

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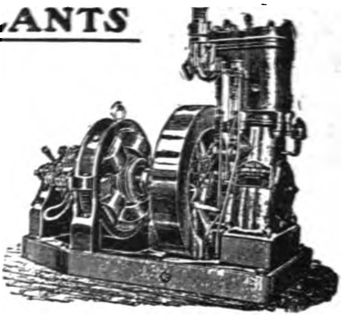

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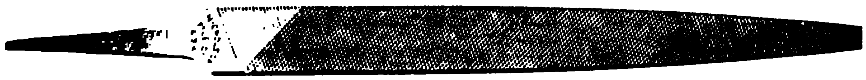

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THE
ENGINEERING MAGAZINE
"THE WORLD IS ITS FIELD"

VOL. XXVI. MARCH, 1904. No. 6.

THE WORLD'S GREAT LABOR SAVERS AND LABOR SERVERS.

By Robert W. Hunt.

There are two methods of treating such a theme as is suggested by the title of Mr. Hunt's article. One is the comprehensive historical survey; in so vast a field and so limited a space for record as we have here, the result could scarcely be more than a chronological list. The second mode of treatment is the selection of some typical period or movement, and the restoration of it before our eyes,—the resetting of the stage with the atmosphere of the time it recalls and the living personality of the characters who then played their parts. It is this latter which Mr. Hunt chooses. His special theme is the development of steel-making —a matter which he justly says lies at the foundation of all modern expansion in the engineering industries. His company is that little band of Anglo-American engineers, fertile in creation, bold in undertaking, tireless in energy, marvellous in organization, among whom his own place was more prominent than his modesty permits him to disclose. And his narrative is vital with the life which is given by the intimate bond with the things it sets forth, and warm with its nearness to the great actors (some of them still living) in the events with which it deals.—THE EDITORS.

IT certainly is an inherent quality of the human mind to seek the lightening of whatever manual labor the environment of habitation may require. This has been manifested in all known ages, and the discovered relics of prehistoric man point to the same fact. And it is notable that either the development of these labor-saving devices has brought about an equal elevation of human condition, or else such bettered conditions have demanded, and hence commanded, the devices. At all events they have practically gone together.

It needs no argument to prove that the physical, moral, and mental condition of the tiller of the soil in all civilized countries is far in advance of that of the same class in past generations; and in no occupation has there been greater development of labor-saving machinery. The man preparing the soil for the receipt of grain by the use of a

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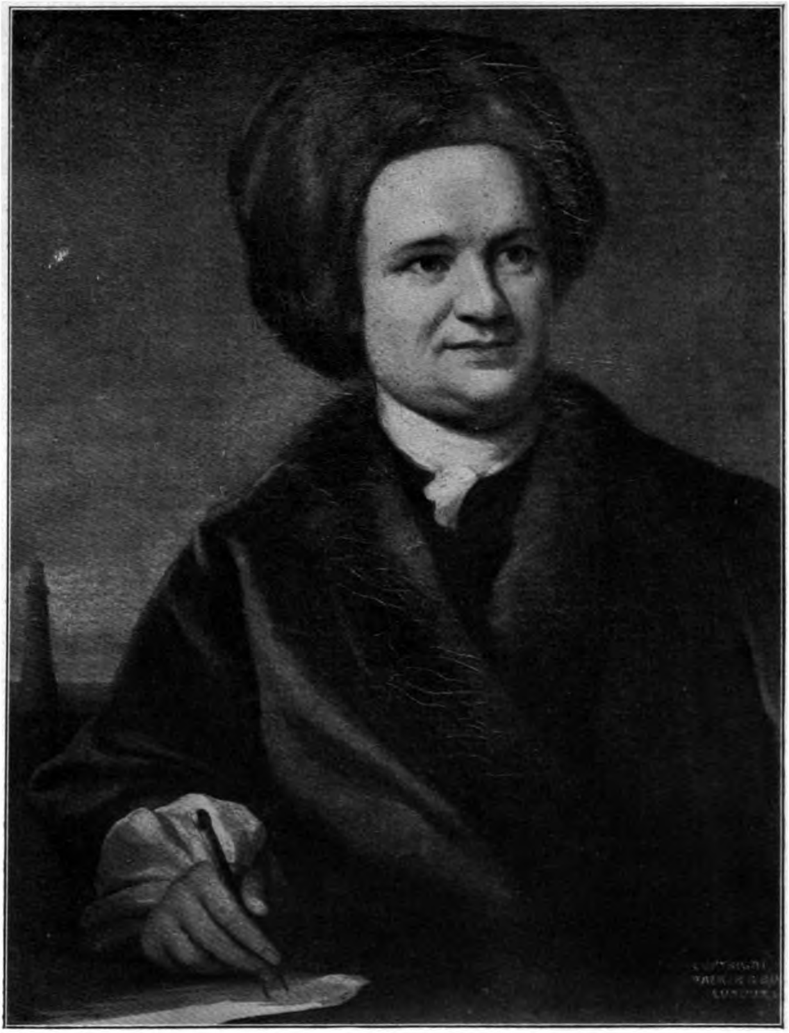
sulky plow, has to be a higher organism than he who scratched the ground's surface with a bent stick, or even a grubbing hoe. And the rate of development of the man has been equal with that of the tools used by him. So it has been in all the occupations of life. To write of them all would fill an encyclopedia, and thus go beyond my part in this intended series of articles. Therefore in making my contribution to it, I shall chiefly confine myself to the branch of manual activity with which I have been most intimately associated, and so shall write of the development of labor-saving machinery. in the making of iron and steel. In that industry it has been remarkable both in rapidity and results. In fact, iron and steel may be considered as the foundation stones upon which the edifice of civilization rests. Their development and growth have made all else possibie.

As mankind progressed, the time came when iron became a necessity; its ores were found and in some way its extraction from them discovered. For a long time only the direct processes of obtaining malleable iron were known—this because of their simplicity, and that of the required apparatus. As the use of the metal increased, it was wanted in masses which it was impossible to obtain in that way, even though developments and improvements had taken place. And there was also that never-ending demand for cheaper material. So came the blast furnace, yielding, at less cost, metal in greater quantities, and capable of being formed in larger masses. This for many purposes had to be further treated before being used, but used as a base it permitted results which it was impossible to obtain from the directly reduced product.

Such furnaces required the handling of larger quantities of ore, flux, and fuel, and so naturally led to the invention and perfecting of mechanical labor-saving means of so doing; and each subsequent step forward has accentuated this. No one thing can stand alone; the growth of one affects all others. The early blast furnace had its blast from water-power-driven bellows; the iron ore and limestone and fuel were charged into it by actual hand labor, and its 5, 10, to 30 tons of produced iron carried from in front of it by the same power. The furnace of today receives its burden from automatically handled skips, which have themselves been automatically filled from chutes; and the resulting daily product of 500 to 700 tons of metal is taken away in ladles, while yet liquid, or else mechanically cast into pigs, and loaded upon cars, all with the expenditure of the minimum amount of human labor, and the blast for smelting has been blown by the highest type of steam engines, the latest advance being the replacement of the steam



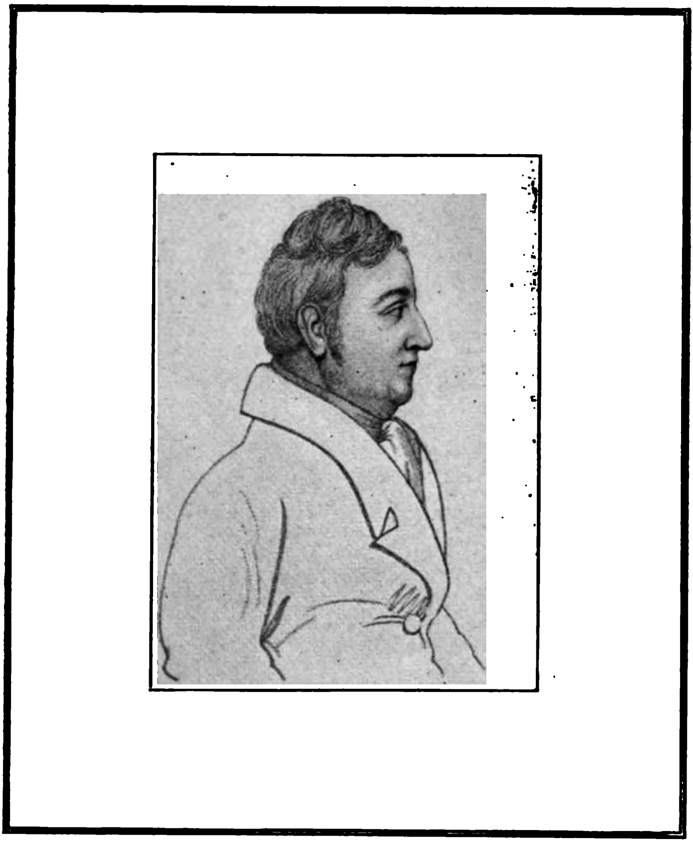
JOHN SMEATON, F. R. S. 1724-1792.

From Rodes' portrait, National Portrait Gallery. Copyright by Walker & Boutall. Engineer of Ramsgate harbor, the Forth & Clyde canal, the second Eddystone lighthouse, and much important bridge work. His chief mechanical work was in the vast improvement of mill machinery and in the great advances he made in the development of Newcomen's steam engine. In this, however, his work was eclipsed by that of Watt.

SIR RICHARD ARKWRIGHT. 1732-1792.

From the painting by Joseph Wright, A. R. A. Copyright by Walker & Boutall.

Famous for inventions in cotton spinning—the first great step in powering the textile industries, and one which made cotton manufacture the leading industry of the north of England. Began life as a barber; entered upon his inventive work in 1767, and took out his patent in 1769. Knighted in 1786.



EDMUND CARTWRIGHT, D. D. 1743-1823.

Inventor of the power loom—the second great step in the textile industry. It was suggested to him, he says, in 1784, by his perception of the fact that Arkwright's spinning machinery could turn out more yarn than all the hand weavers of the world could use. His patent was taken out in 1785-7. Inventor also of a steam wheel, a surface condenser, segmental piston packing, and other devices.

by the furnaces' own waste gas. To produce that 500 tons of iron required at least 1,400 tons of raw material, the supplying of which could be possible only by the use of labor-saving machinery in each step of handling, clear back to where the ore, lime, and coal were taken from the ground.

As stated, iron was first obtained from the ore by direct processes; this put it into the form of blooms which were subsequently forged into bars and other shapes under hammers—originally hand-wielded, but later driven by water power, and still later, by steam. Long before this latter time however, the work of the hammer had been sup-

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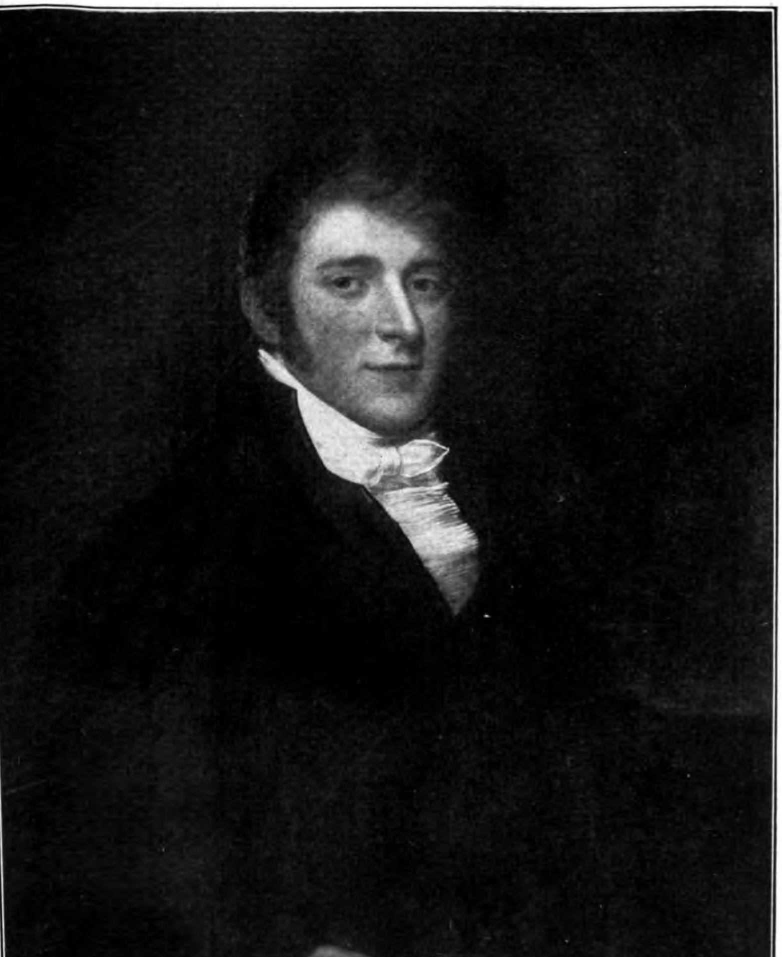


ROBERT FULTON. 1765-1815.

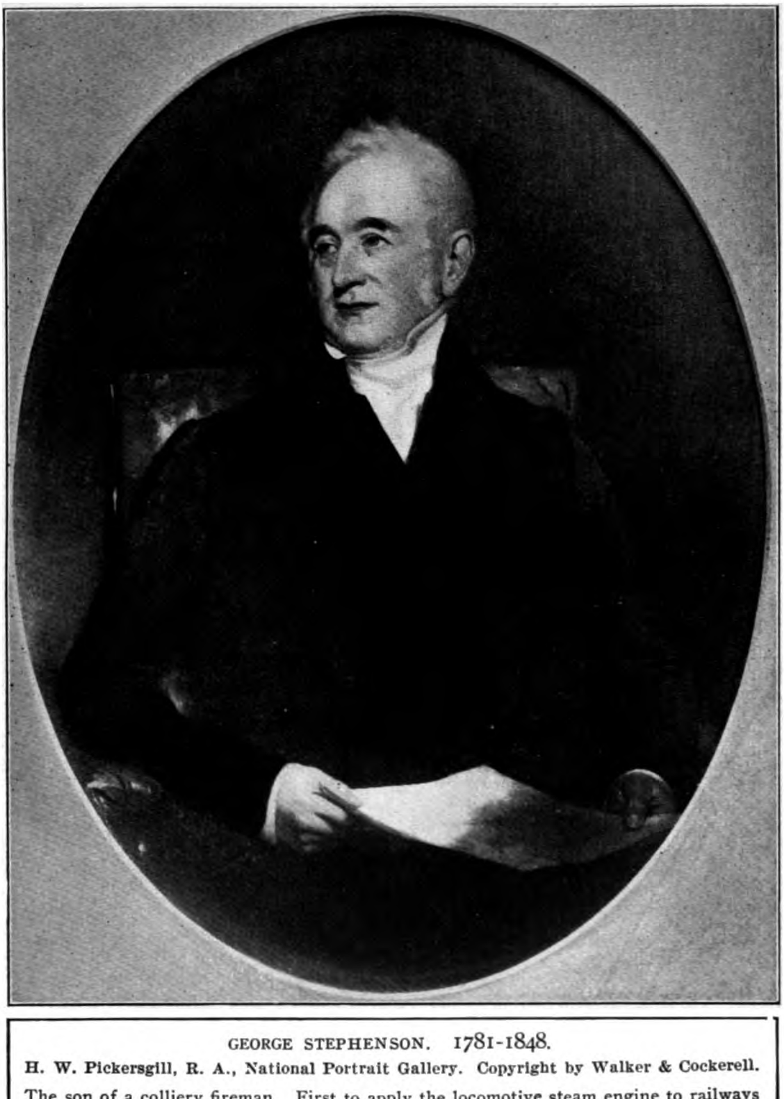
Portrait painted by himself, now owned by American Society of Mechanical Engineers. First distinguished as a talented and successful artist. While in England, as a pupil of Benjamin West, he met James Watt, Lord Stanhope, and the Duke of Bridgewater, father of the British canal system. In 1803 undertook to build a steamboat on the Seine; in 1807 launched the successful Clermont.

plemented by the use of rolling mills, between the cylinders of which the metal was pressed into shape; these also being driven by water power. The elevation of mankind continued and demanded and received the invention of the steam engine, the development of which made possible the location of iron-making plants at points remote from water falls, and thereby broadened that industry.

As communities increased and the demands of living grew, transportation of persons and material became a matter of supreme importance. Roadways and vehicles were improved, until following the invention of the steam engine, came the locomotive and the iron road bed on which it was to run. Remember each of these steps in advancement came slowly, and each gave to mankind increased comfort and individual expansion.

There was much uncertainty as to the kind of road bed which would be necessary for these fire-breathing monsters; but that they must run on metal ways was conceded. At first these were made by simply spiking flat bars of iron upon the tops of longitudinal wooden stringers. Later cast-iron rails were used, and these were followed by wrought-iron ones; but for many years the flat strap rails were the ones in general use. While they permitted what was considered most admirable results, they absolutely prevented greater development in the way of increased speed and weight of rolling equipment. This limitation led to the rolling of wrought-iron rails of various forms—first the bridge or U, and then the T-shaped sections. These latter were designed by Charles B. Vignoles, an English engineer, and Mr. Robert L. Stevens of the United States at about the same date. This brings us to what proved to be an epoch in rail making, and incidentally in the railway history of the world.

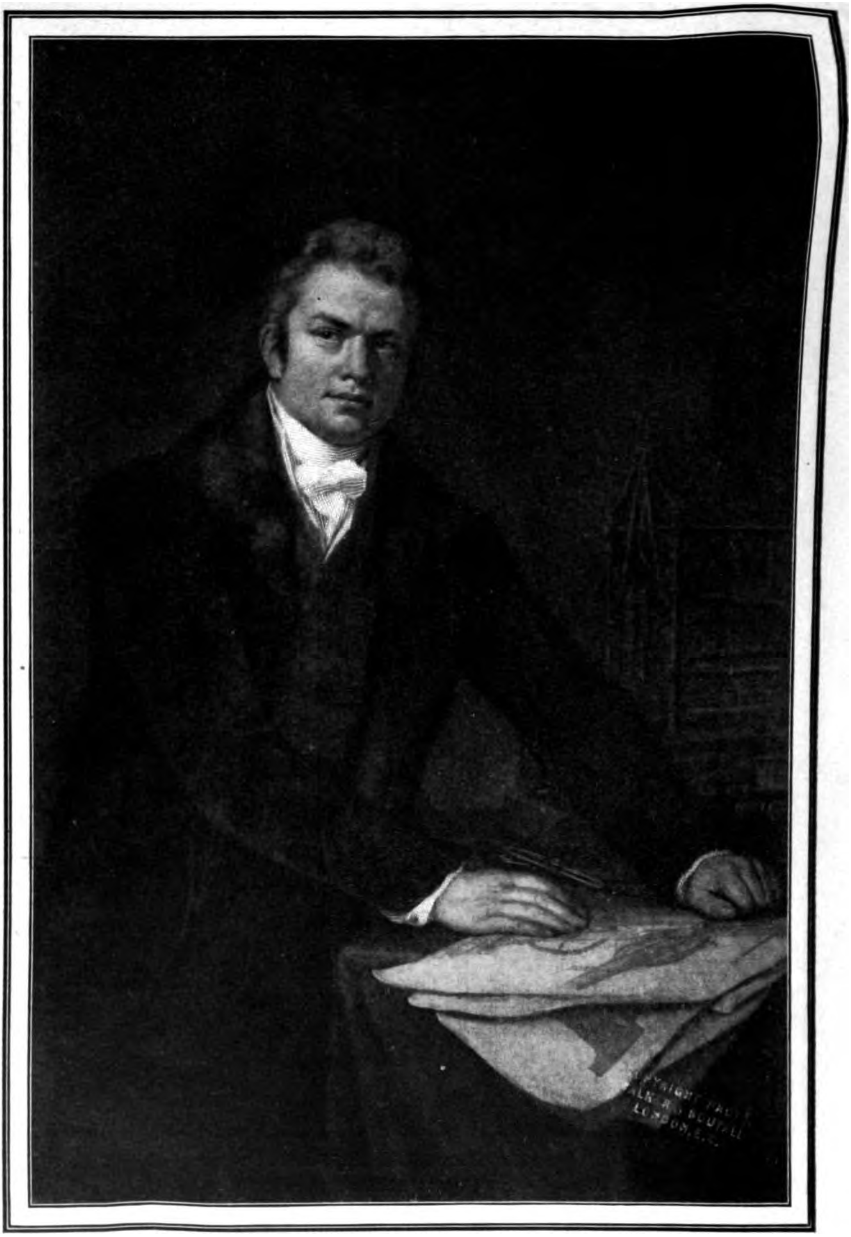
The first American rail mill, that is, one built to produce other than strap-iron rails, was the Mount Savage Works, situated in Allegheny County, Maryland, erected in 1843. This was followed quickly by other mills, the enterprises meeting with varying and not always successful experiences. In 1853, the Cambria Iron Works were built in Johnstown, Pa., to manufacture iron rails. The location was selected because of an abundant iron-ore and coal supply; these two minerals being deposited in the same hills, and within a few yards of the selected blast-furnace and rolling-mill sites. There had been preceding iron works in the locality, designed to make other products than rails, but they had passed away. The iron ore which had been used by the earlier establishments, and which led to the building of the Cambria Iron Works, was the outcropping of silicious carbonate. The



GEORGE STEPHENSON. 1781-1848.

H. W. Pickersgill, R. A., National Portrait Gallery. Copyright by Walker & Cockerell.

The son of a colliery fireman. First to apply the locomotive steam engine to railways for passenger traffic. Patented his locomotive in 1815, and constructed the first railway, between Stockton and Darlington, in 1825. The "Rocket" ran in 1830. Chief engineer to most of the railways built during the ensuing ten years in Great Britain.



SIR MARC ISAMBARD BRUNEL. 1769-1849.

From Northcote's painting, National Portrait Gallery. Copyright by Walker & Boutall.

Educated first for the church, then for the navy. Carried on important **engineering work** —notably the Thames tunnel and the promotion of steam navigation. **His significant** labor-saving achievement was the design and introduction of wood-working **tools** for making ships' blocks by machinery.

ISAMBARD KINGDOM BRUNEL, F. R. S. 1806-1859.

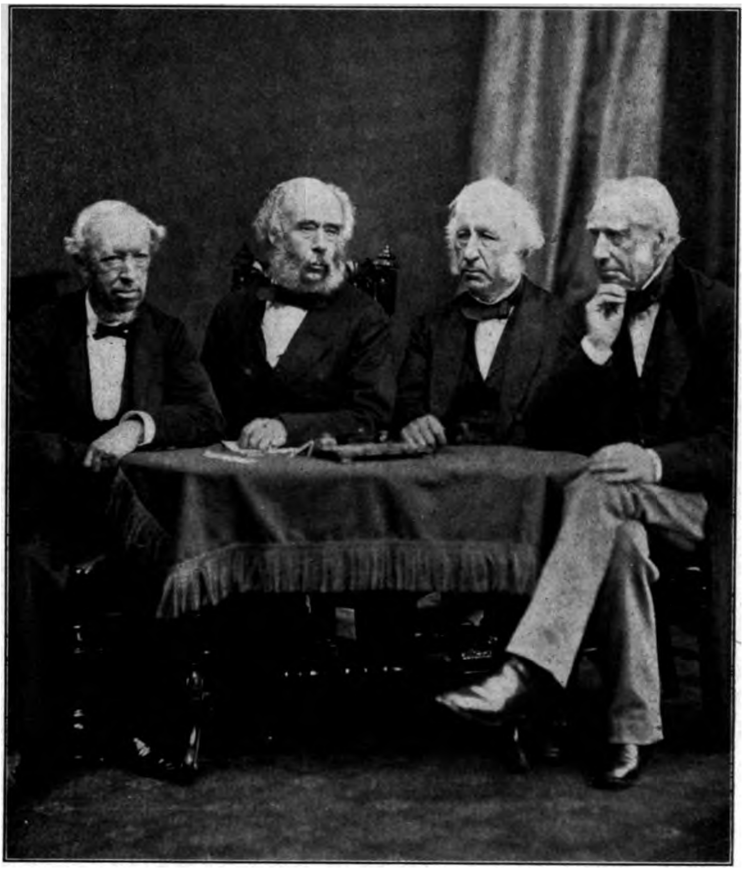
From portrait by Horsley, National Portrait Gallery. Copyright by Walker & Cockerell.

Son of Sir Mark Isambard Brunel, and at first his assistant. He designed the Great Western —the first great ocean steamer—and built the Great Eastern, until lately the largest vessel ever completed. As engineer of the Great Western Railway he was a leading genius in the development of railway transport.

operations of the small plants had been more or less satisfactory, but the consumption of the greater works soon exhausted the outcrop and compelled the use of the leaner ore, which produced iron of inferior quality. When puddled it was both red- and cold-short. While the hardness incident to the latter gave good wearing rail heads, the red-shortness rendered it difficult to obtain finished rails of which the flanges were not so badly cracked that they had to be thrown on the scrap heap.

Iron rails were rolled from a pile composed of a number of bars of wrought iron placed one upon the other, brought to a welding heat in a furnace, and then passed between the grooves of rolls, which welded them together, and gradually elongated and formed the mass into a finished rail. Up to July, 1857, all rails at Cambria and other mills were rolled on non-reversing two-high trains of rolls. That is, there were but two rolls in a set, and as they were driven constantly in one direction, the metal which was being drawn into shape by their grooves could be rolled only in that direction. After each passage between the rolls, the pile, or bar, had to be passed back over the top roll, its revolution assisting in this. Of course quite as much time was consumed in this passing back as in the opposite rolling or reductions. Not only was time consumed and the amount of production limited, but the metal under treatment lost heat, and thus augmented the difficulties in obtaining satisfactory welds of the several slabs of iron composing the rail piles and freedom from "red-short" cracks in the finished rail. The difficulties at Cambria continued to increase, and, with no other available ore supply, were at last so serious that the prospects of the company were gloomy indeed. On this establishment the entire community were dependent, and its failure, and from such a cause, meant their ruin, without hope for the future. But, as has so often and so providentially happened in the world's history, a man arose who was equal to the emergency, and while saving the immediate situation, by his invention of labor-saving machinery, also installed that which was destined to revolutionize the rail industry of the country.

Mr. John Fritz was then the chief engineer of the Cambria Company. I can best describe the situation by repeating what I wrote on a former occasion. His keen mechanical perception and good judgment saw the solution of the problem. It was to save the time and heat lost in passing the bar back in idleness over the top roll; this could be done by adding another or third roll, and so making that which had been the top, a middle one. This top roll, revolving in the opposite direction to the middle one, permitted grooves to be added,

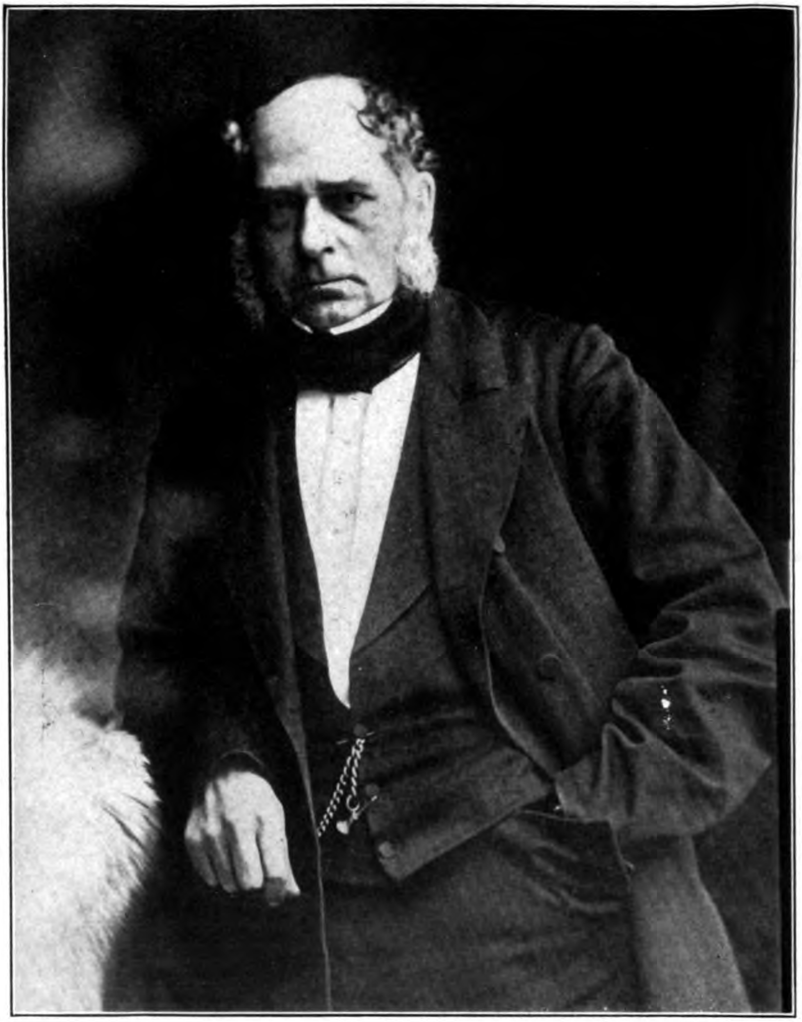


John Penn. **Joseph Whitworth.** **R. Napier.** **W. Fairbairn.**

A GROUP OF LEADERS OF ENGINEERING OF THE EARLIER NINETEENTH CENTURY.

Sir Joseph Whitworth was a pioneer in the building of machine tools, and in standardization in mechanical manufacture. Sir William Fairbairn's early work was in the substitution of iron for wood in machinery, in the economical reduction in weight of shafting and metal sections, and in systematic and scientific testing of materials of construction. Robert Napier was among the first of the steamship builders, and in 1840 furnished the Cunard Company their first four steamers. The portrait was taken at the Manchester meeting of the Institution of Mechanical Engineers, 1866, and the engraving is from a rare original photograph in the possession of the American Society of Mechanical Engineers.

in which the metal could be reduced as it was brought back to the front of the train of rolls. To accomplish this successfully, he invented the Fritz "Yielding Hanging Guides and Driven Feed Rollers." This solution seems now so simple a one. But we must remember that at the time of its conception, rolling mills were considered old institutions, and their designers and managers thought themselves, and were



SIR HENRY BESSEMER. 1813-1898.

From a life photograph in possession of the American Society of Mechanical Engineers.

Began life as a modeller and designer, taking up mechanical processes for replacing manual toil. His pneumatic steel-making process was announced in 1856 but perfected only in 1859. At first ridiculed by ironmasters, it eventually revolutionized the world's materials and methods of engineering construction.

thought by others, to be very smart men. Moreover, there were difficulties in the construction and operation of this proposed mill which would appear only to those possessed of some practical knowledge. Indeed, some of those high in the councils of the Cambria Company entered solemn and official protests against that crazy man, Fritz, being permitted to waste the company's money. Its affairs were badly enough off, as it was, without adding this foolishness.

In addition, some of Mr. Fritz's brother engineers and intimate friends compelled themselves, as a matter of fraternal duty, to labor with him against his folly, and thus prevent his scattering to the winds his most excellent and hard-earned reputation. In spite of all, he had the courage of his convictions, and the new mill was built. It proved a success, and the situation was saved. All the other rail mills in America subsequently adopted the plan. The Cambria Company continued to prosper and has for many years been one of the largest iron and steel producers of the world. The little village of Johnstown has grown into a city of many thousands, and this in spite of a later awful calamity, which caused the greatest disaster to life and property known to civilization.

This labor-saving invention of Mr. Fritz was the basis on which American rail-mill practice grew, and helped forward by other labor-saving inventions of himself, his brother George Fritz, William R. Jones, and others, led to that progress which ultimately placed the United States pre-eminently ahead of the world in rail production. These results have been accomplished only by hard work, and the application of much mechanical and executive ability.

John Fritz left Johnstown in 1860 to become the active head of the Bethlehem Iron Company, at South Bethlehem, Pa., where he continued his labors with the same character of beneficial results for his country and fellow men. A list of his labor-saving machinery would be a long one, and perhaps what will stand as the crowning glory of his career will be his successful introduction into the United States of the manufacture of steel armour. He had the acumen to use the best European designs, but also the ability not only to improve upon them but also from the very first, to make the enterprise a success.

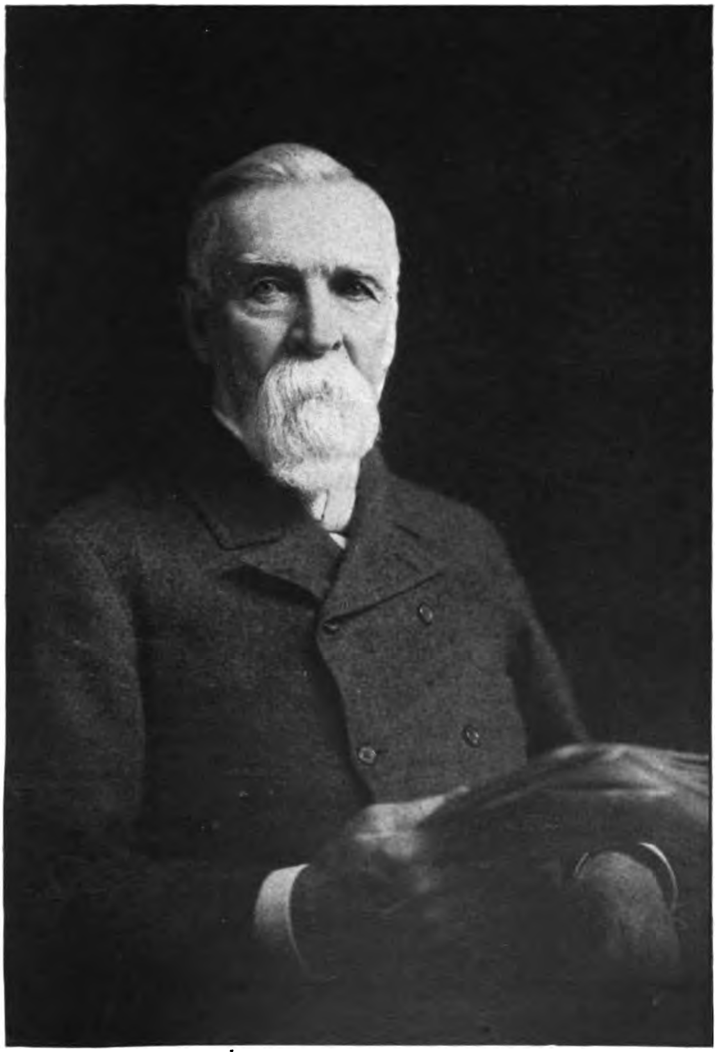
Some years ago, the United States Government thought seriously of establishing its own armour and ordnance works. Mr. Fritz was employed to prepare the plans for it, and to submit an estimate as to its cost, and the price at which material could be produced. When the then Secretary of the Navy presented him to the Congressional Committee having the matter in charge, he said: "Gentlemen, I present to you Mr. John Fritz, the most honest man I have ever known." Mr. Fritz's days of usefulness are not yet over, and may the world be blessed by his presence for many years to come!

Mr. John Fritz was succeeded at the Cambria Works by his younger brother George Fritz, who while unlike him in many traits, was his counterpart in sterling uncompromising honesty and great mechanical skill. Under his direction, the works continued to grow and prosper. The introduction of the Bessemer process for making steel found him in mechanical and manufacturing charge of the works. As Mr. William Kelly—who had been granted American patents on the process as against those issued to Sir Henry (then plain Mr.) Bessemer—had conducted many of his experiments at the Cambria Works, George Fritz was quite familiar with the subject. Moreover, the Cambria Iron Company had joined a syndicate of American manufacturers in purchasing Kelly's patents as well as Robert Mushet's American one, which covered the step by which the process had been made a commercial success. Daniel J. Morrell was the general manager of the Cambria Company; he was a man of broad mind, and had become thoroughly convinced of the great potentiality of the pneumatic process of steel making. It seems hard to believe now that any one ever doubted, but many did; having among their number some of those who were considered as of the highest authority upon iron and steel manufacture.

I remember hearing Mr. Morrell say to his board of directors, while the question of entering upon the construction of Bessemer works was being discussed, to which some of them were strongly opposed: "You may think me crazy, gentlemen, but if you will pay me the book value for my Cambria stock, I stand prepared to put every cent of it into a Bessemer plant."

While as stated, a combination of American companies had secured Kelly's and Mushet's patents for their country, the American Bessemer patents had been purchased by the firm of Winslow, Griswold & Holley, and naturally there was a legal contest, which threatened not only to cost the parties in interest much money, but also to interfere with the introduction of pneumatic steel in the United States. Mr. Morrell fully realized the unfortunate situation, and it was largely through his exertions that a compromise was reached, and a combination of the conflicting interests.

Ultimately the company decided to build a plant. George Fritz designed this, Alexander L. Holley acting as consulting engineer. But Mr. Fritz was very radical in his views, and while availing himself



JOHN FRITZ. BORN 1823.

One of the foremost agents in moulding the destinies of the industrial world by developing the iron and steel manufacture. His invention and courageous introduction of the three-high rail mill "was the basis upon which American rail-mill practice grew."

GEORGE FRITZ. 1828-1873.

From the only known portrait. By courtesy of John Fritz, Esq.

A pioneer in the American Bessemer process. By his labor-saving **inventions he** placed himself among the leaders of "that progress which ultimately **placed the** United States pre-eminently ahead of the world in rail **production."**

of Holley's advice, made many departures from the designs of any plants built up to that time, and what was more important, designed and built a three-high blooming mill with automatically lifting and driven feed tables, on which to roll the steel ingots.

During part of the time while the Cambria Company was hesitating about erecting the steel works, they had been taking the Bessemer steel made by the Pennsylvania Steel Company, at Steelton, Pa., of which A. L. Holley was in charge, and rolling it into rails at one of their mills which was designed for rolling iron rails, other rolls of course, being used. At first some of the ingots were hammered into blooms at Steelton, and others at Johnstown; at the latter place, under a steam hammer which had been put in some time before to hammer iron slabs to form the heads of iron rails for the Pennsylvania Railroad, in the effort to improve their wearing quality. The short life of iron rails under the increased stress of traffic had caused railway managers much expense, and seemingly brought railway development to a standstill. These steel blooms were then reheated, and as stated, rolled into rails in one of the existing mills. The first ones were produced in August, 1867, on an order from the Pennsylvania Railroad Company, and were the first commercially rolled steel rails in America.

George Fritz concluded that this was not the proper manner of treating the metal. He had blooming rolls prepared, and placed in one set of the rail-train housings. Mr. Holley sympathized with the experiment, and sustained it by having ingots 8½ inches square cast, and sent to him. These were bloomed by the rolls to 6½ inches square, recharged in the heating furnaces, wash-heated, and then rolled into rails. This practice was successful, and I believe this was the first cogging, or blooming mill. Its success led to the final abandonment of the formerly universal practice of first hammering the ingots—a practice which would have made it absolutely impossible for the world's subsequent requirements of steel rails to have been met.

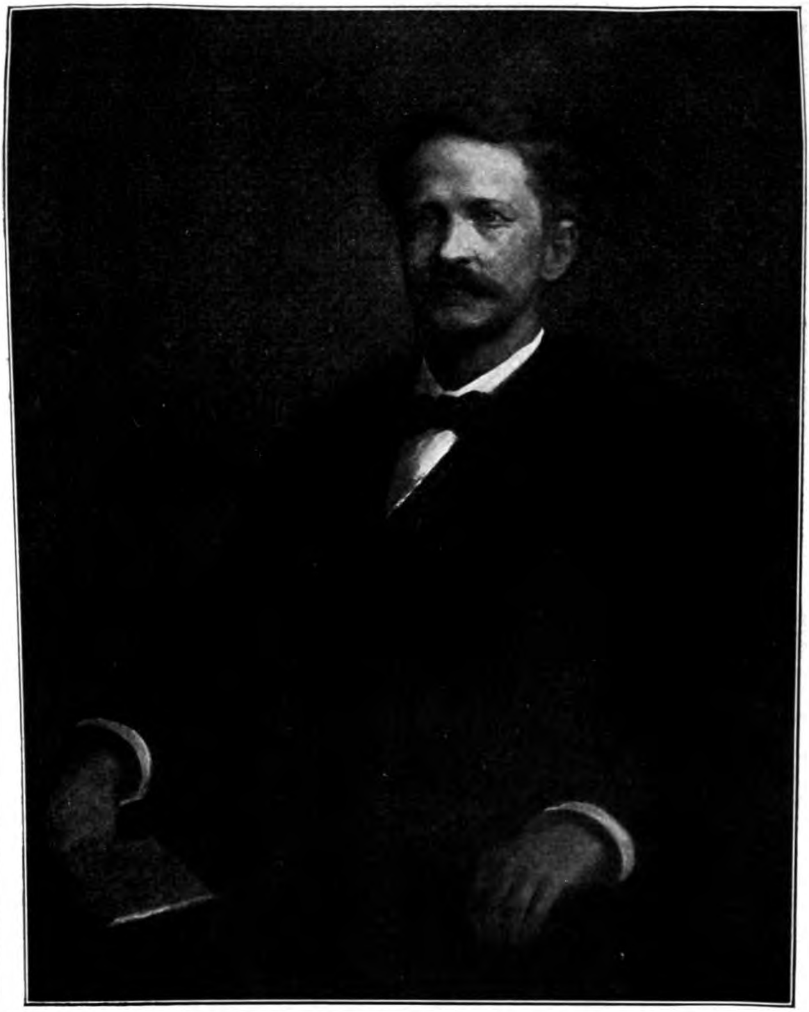
In 1868 Mr. Holley relinquished the management of the Pennsylvania work, and again took charge of the Troy, N. Y., Bessemer Works, which he had originally built. In January, 1871, he started a three-high blooming train, designed from consultations with John and George Fritz. It had lifting tables operated by hydraulic power, but their rollers were undriven, which required the ingots, after being placed on them, to be pushed by hand into the rolls. It required eight men to operate the mill, and was a decided advance.

George Fritz started his Cambria blooming mill on July 10, 1871; the same day the converting works made its first heat of steel. As already stated, its tables were power-driven, and the number of men required to operate the mill was reduced to four, and its producing capacity increased many fold. In fact, the present typical American blooming mill on which over 75,000 tons of ingots have been rolled in a single month's work, is practically a Fritz mill.

It must be remembered that John and George Fritz and Alexander L. Holley were warm personal and professional friends, which led to frequent interchange of ideas, and their work was always in accord, and without the least taint of jealousy. With three such men, no wonder such tremendous results were accomplished. Unfortunately for the world, George Fritz died on August 5, 1873, mourned by some 5,000 workmen employed by the Cambria Company, as their true friend, and one who had accomplished much in their behalf. I was personally associated with him for thirteen years, and loved him well. I regard him as having been one of the most talented mechanical engineers whom I have ever known.

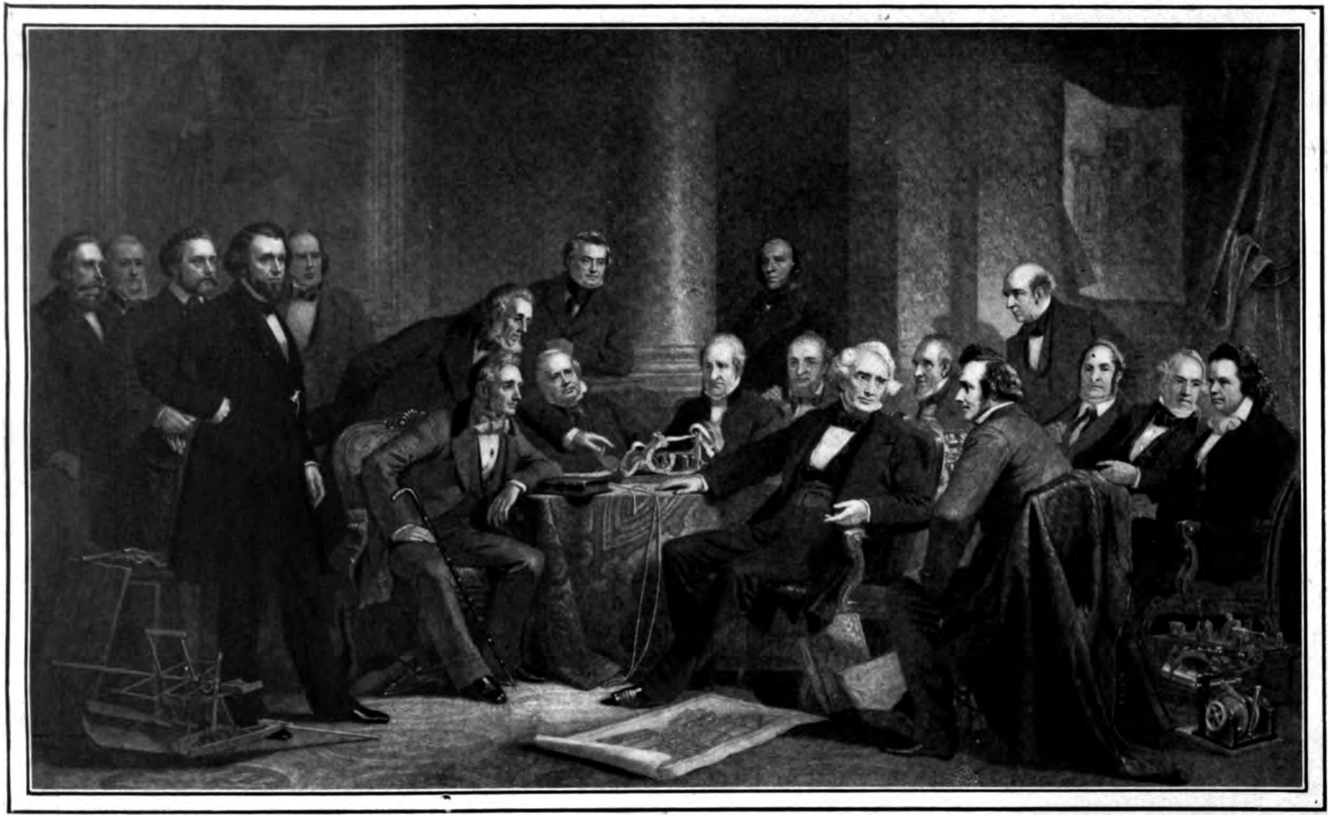
Sir Henry Bessemer's invention of the pneumatic process of making steel proved to be one of the most revolutionary incidents which have ever occurred in the world's economic history. There have been other great mechanical and metallurgical and other scientific developments, but the steam engine, pneumatic steel, and the telegraph, stand pre-eminently forward.

The limit of railway development, so far as speed of trains and weight of equipment, had been reached. In many places, the stress of traffic was so great that iron rails would last but a few months, and all efforts to increase their wearing quality had seemingly failed. Had such limitations been permanent, it is bewildering to try and realize that which would not have taken place in human progress. But this new way of making metal was not at once accepted as being a success. In fact it was not, until other minds than Bessemer's had worked upon it. Goransson of Sweden did his part in actual demonstration, but most important of all, Robert Mushet discovered the controlling effect of the addition of metallic manganese. Still the commercial world was slow to believe. Alexander Lyman Holley was in Europe at this time, and with his keen insight, was quick to appreciate the importance of the matter, and also what it would in time mean to America. After much persuasion, he succeeded in interesting John A. Griswold and John F. Winslow, iron manufacturers of Troy, N. Y., and the firm of Winslow, Griswold and Holley was formed; representing which, Mr. Holley after much negotiation, secured from Bessemer the United States rights to his patent. Holley at once returned to America and



ALEXANDER LYMAN HOLLEY. 1832-1882.

From a portrait given by his widow to the American Society of Mechanical Engineers. Early associated with Corliss in steam-engine and locomotive work. Entered journalism as an engineering expert, and investigated the Bessemer process in 1863. He threw himself into the engineering problems of this and of the Siemens-Martin and Thomas-Gilchrist processes and played a most influential part in their adaptation and introduction into the United States.



JAMES BOGARDUS. *Iron buildings*
JOSEPH SAXTON. *Fine machinery*
PROF. HENRY. *Electro magnetism*
JOHN ERICSSON. *Marine engineering*
ERASTUS BIGELOW. *Carpet loom*
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HENRY BURDEN. *Iron working*
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RICHARD HOE. *Rotary press*
ELIAS HOWE *Sewing machine*

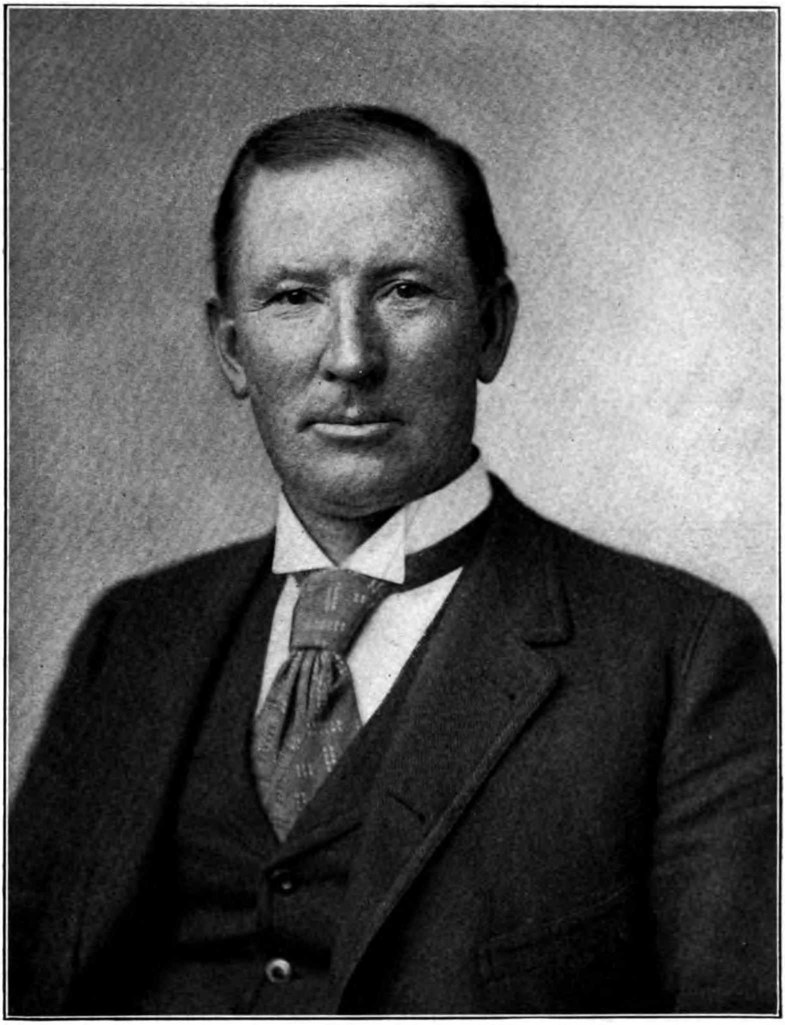
"AMERICAN MEN OF PROGRESS." FROM AN ENGRAVING PUBLISHED BY THE SCIENTIFIC AMERICAN IN 1861, REPRODUCED HERE BY THEIR COURTESY.

erected an experimental plant at Troy, N. Y. I have previously alluded to there having been a patent conflict between the Kelly and Bessemer interests; while this was pending, Holley's hands were somewhat tied, but his brain was busy, so that when the trouble was happily settled, he was prepared to enter at once upon that brilliant career in connection with America's pneumatic and open-hearth steel industry, which gave to him such fame and to mankind so much good. Accepting the metallurgical conditions, Holley at once attacked the mechanical ones. He did away with the English deep pit and raised the vessels so as to get working space under them on the ground floor; he substituted top-supported hydraulic cranes for the more expensive counter-weighted English ones, and put three ingot cranes around the pit instead of two, and thereby obtained greater area of power. He changed the location of the vessels as related to the pit and melting-house. He modified the ladle crane, and worked all the cranes and the vessels from a single point; he substituted cupolas for reverberatory furnaces, and last, but by no means least, introduced the intermediate or accumulating ladle which was placed on scales, and thus insured accuracy of operation by rendering possible the weighing of each charge of melted iron, before pouring it into the converter. These points cover the radical features of his innovations. After building such a plant, he began to meet the difficulties of details in manufacture, among the most serious of which was the short duration of the vessel bottoms, and the time required to cool off the vessels to a point at which it was possible for workmen to enter and make new bottoms. After many experiments, the result was the "Holley Vessel Bottom," which, either in its form as patented, or in a modification of it as now used in all American works, has rendered possible, as much as any other one thing, the present immense production.

At different times he was in direct charge of the Troy and Pennsylvania steel plants, but in time his services were extended as consulting engineer to practically all of the Bessemer plants of the country. He built the two Troy, and completed the original Pennsylvania works; was consulting engineer during the construction of the Cambria, North Chicago, Joliet, St. Louis, Edgar Thomson, and Bethlehem plants, and was finally employed as consulting engineer by the Bessemer Association, composed of all the American Bessemer Companies.

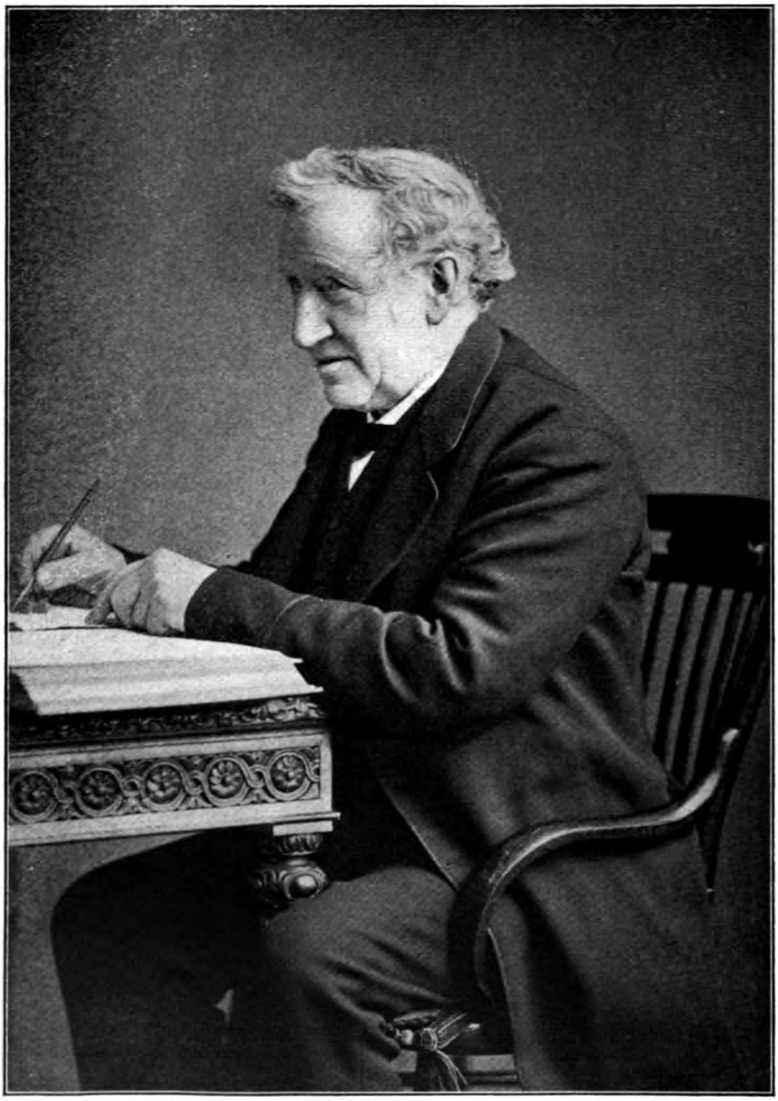
The inventions of Thomas and Gilchrist made possible the dephosphorization of the iron in both the Bessemer and open-hearth processes, and early enlisted Holley's appreciation. This and the other developments in the Siemens-Martin or open-hearth steel making, convinced him of its great future, and he persevered in his efforts to enlist the interest of American manufacturers; indeed, he went so far as to predict that in time the open-hearth would supplant Bessemer steel in America. This has not yet occurred, but the increase in the production of the former has fully kept up with the latter, and the fulfillment of his prediction looks much more probable than when it was made. It would be impossible to reproduce today the conditions existing from 1865 to 1882. The country was much younger than the number of years which have passed since then seem to represent. Any one who has not lived through them cannot appreciate the tremendous changes which have occurred; and in no way have they been greater than in the iron and steel business. In 1866—the year following the close of the civil war—there were 1,205,663 gross tons of pig iron produced in the United States. In 1902 were made 17,821,307 gross tons of pig metal, including speigeleisen and ferro-manganese; 6,512 gross tons of iron, 2,941,421 gross tons of steel rails, with a total production for the year, of 9,138,363 gross tons of Bessemer, and 5,687,729 gross tons of open-hearth steel.

The civil war had cleared the political atmosphere, and its experiences had developed a generation of active, aggressive men. There were then fewer iron and steel works and new fields of development presenting themselves; of those, the most attractive was the Bessemer with Holley as its champion. Those who knew him can alone realize how wonderful was his magnetism; how while of all men he was manly, there was still a personal charm that was almost that of a woman. Crowning all were talents granted to few. He was Holley —no man has been like him. It was no wonder that such a man enlisted the enthusiasm of all the young men connected with the various companies, and others with whom he came in contact. Robert Forsyth, P. Barnes, D. N. Jones, Owen Leibert, John E. Fry were among them. There was one other, Captain William R. Jones. He came out of the civil war with the rank of captain after having originally enlisted as a private. On returning to his home, Johnstown, Pa., he resumed his trade of machinist to be appointed almost at once by George Fritz as his mechanical assistant. As such he remained until Mr. Fritz's death; after which he went to the Edgar Thomson Steel Works, which were then being erected near Braddock, Pa., by a company in which Mr. Andrew Carnegie was interested, on plans drawn by Holley; P. Barnes being the resident engineer. Holley had no more devoted admirer than Captain Jones, and he took up his new work with great enthusiasm. Upon the completion of the plant, he



WILLIAM R. JONES. 1839-1889.

At fifteen was earning journeyman's wages as a machinist. At the close of the U. S. Civil War, returned to the Cambria Iron Co. as assistant to George Fritz; later was with Holley, who was consulting engineer to the Associated Bessemer Mfrs. In 1888 became consulting engineer to all the Carnegie companies. The best practical administrator in the American steel industry.



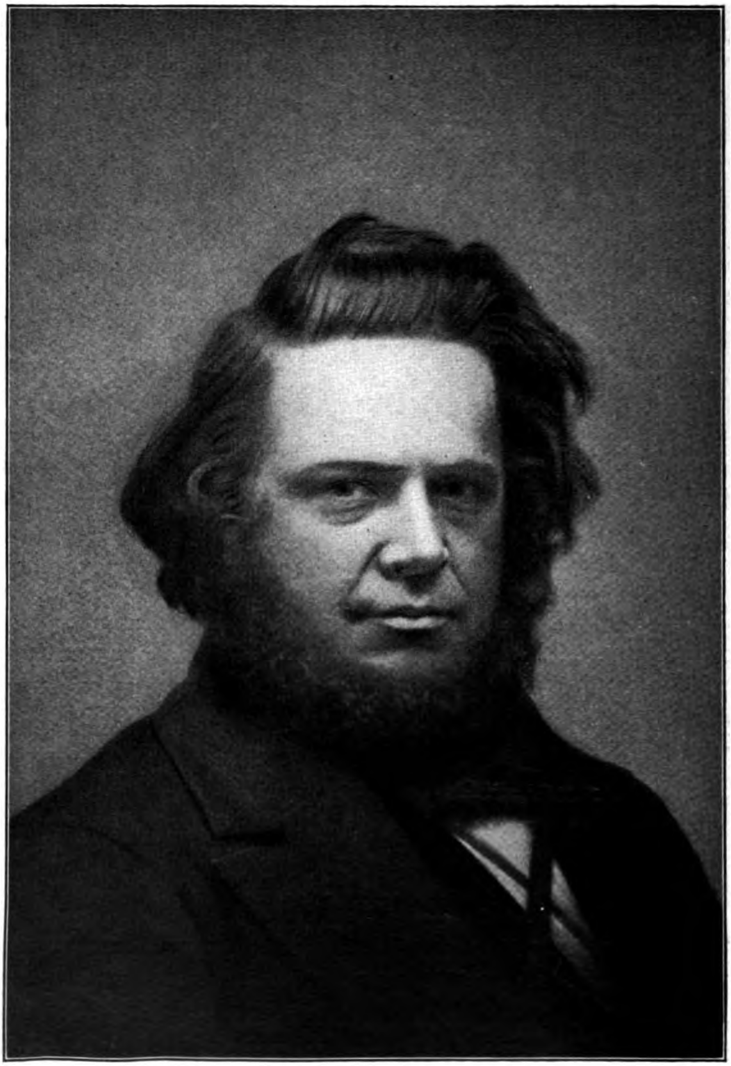
JAMES NASMYTH. 1808-1890.

Mechanical engineer; inventor of the steam hammer and steam pile driver, but particularly identified with the development of the machine-tool industry in England. From an autograph portrait in the possession of Mr. H. H. Suplee.

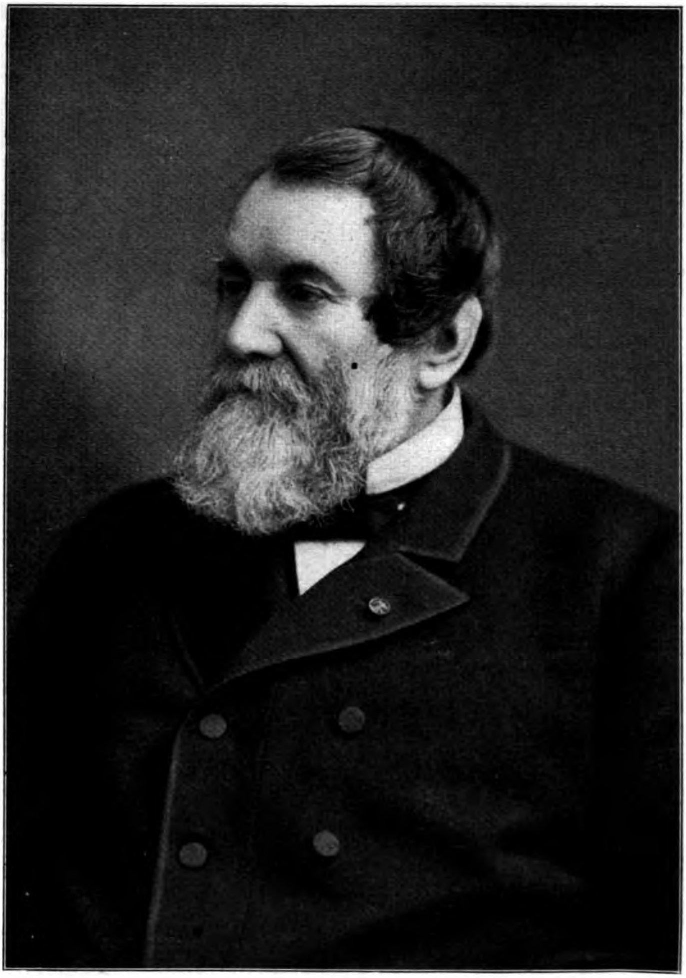
was made its superintendent, and a record-breaking career for man, plant, and company began. Captain Jones was rugged, fearless, and with an honesty almost chivalric. Certain of himself, he did not hesitate to state truths, no matter to whom, and his individuality was such that respectful attenion was accorded him. The mechanical features of the business appealed most to him, and he was afforded by his company ample opportunity for applying his ideas.

It happened to be my fortune to introduce automatic tables attached to a rail train in the mill of the Albany & Rensselaer Iron & Steel Company, Troy, N. Y., in March, 1884. These were further developed and improved; in all of which work I was assisted by Mr. Max M. Suppes, then the master mechanic of the works, and now the general manager of the Lorain Steel Company. This plan to decrease labor and increase output had been discussed by many, but I believe never actually applied up to this time. Holley used to say in that spirit of prophetic jest so constant with him, "that the day would come when we would start a rail mill on Monday morning and then go home after locking the doors, only returning each morning to count the rails that had been made during the preceding twenty-four hours, no other manual labor being necessary." This point has never been reached, but through these tables and their subsequent perfection by Captain Jones, Robert Forsyth, F. H. Treat, and others, the number of men necessary to operate a rail train has been reduced from 15 or 17 to 5, and the monthly production of rails increased from 15,000 to over 50,000 tons.

A few years after this, Captain Jones built a new rail mill for the Carnegie Company, in which he introduced improved tables and several other labor-saving improvements. It had long been desired to use iron in the Bessemer converter, taken direct from the blast furnace, and thus save the labor and cost of remelting, as well as the heat of the liquid metal. While this was done, it was only successfully accomplished in Sweden, where the amounts handled were small, and the iron of very high quality. It was found in larger practice that the metal tapped from the same furnace at different times, and from several furnaces at the same time, varied so much in its composition, that the results were unsatisfactory. Captain Jones built an immense refractory-lined reservoir—or as he called it, "mixer"—into which the liquid iron was transferred as it was taken from the various blast furnaces, and some 150 tons accumulated and mixed. From this mixer, which was suspended on trunnions so that it could be tilted, the metal was taken as wanted for use in the converter. This gave uniformity



ELIAS HOWE. 1819-1867.
Inventor of the sewing machine; it lightened labor and founded new industries.



CYRUS HALL M'CORMICK. 1809-1884.

From his best photograph. By courtesy of Mrs. McCormick.

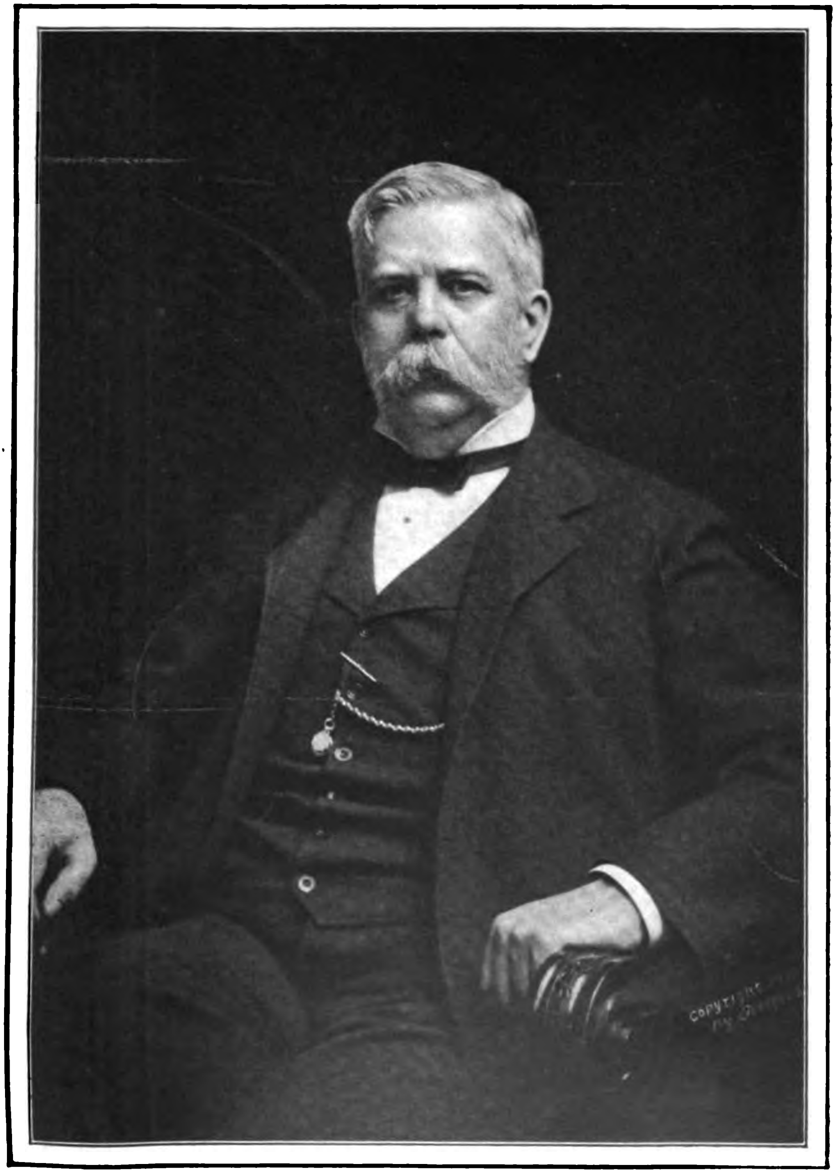
His reaping machine was invented and successfully operated in 1831. It was the first organized appliance for the purpose, and its practical devices have been incorporated in every machine made since. He extended labor-saving methods into the field of agriculture, cheapening and bettering the food of the world.

to it. This plan is now generally used, both in America and Europe. Captain Jones patented the idea, which patent he transferred to his company. Since his death its validity has been attacked, but the United States Supreme Court has sustained his claims. Like George Fritz and Holley, Jones was cut off in full vigor; his death being a tragic one, caused by an explosion at one of the company's blast furnaces.

I have already referred to the great improvements which have taken place in blast-furnace practice. The use of hot blast was a distinct step of progress, and the replacing of the cast-iron stoves for this heating by Whitwell's invention of fire-brick ones, which have since been modified by several inventors, was another great advance. These and the other improvements have all meant labor saving, and not only directly, but through many indirect channels. Among other important developments in the steel business has been that of wire-rod rolling, and the products finished from them. The first signal improvement, certainly in the United States, was made at the Washburn & Moen Manufacturing Company's Works, Worcester, Mass., where a continuous wire-rod mill, after the design and patents of George Bedson of England, was installed. At first this mill was not a success, as iron billets were treated, and that material would not withstand the strain from pulling between the continuous pairs of rolls. Fortunately, about this time Bessemer steel came into general use, and it was found that with it the continuous system was practical.

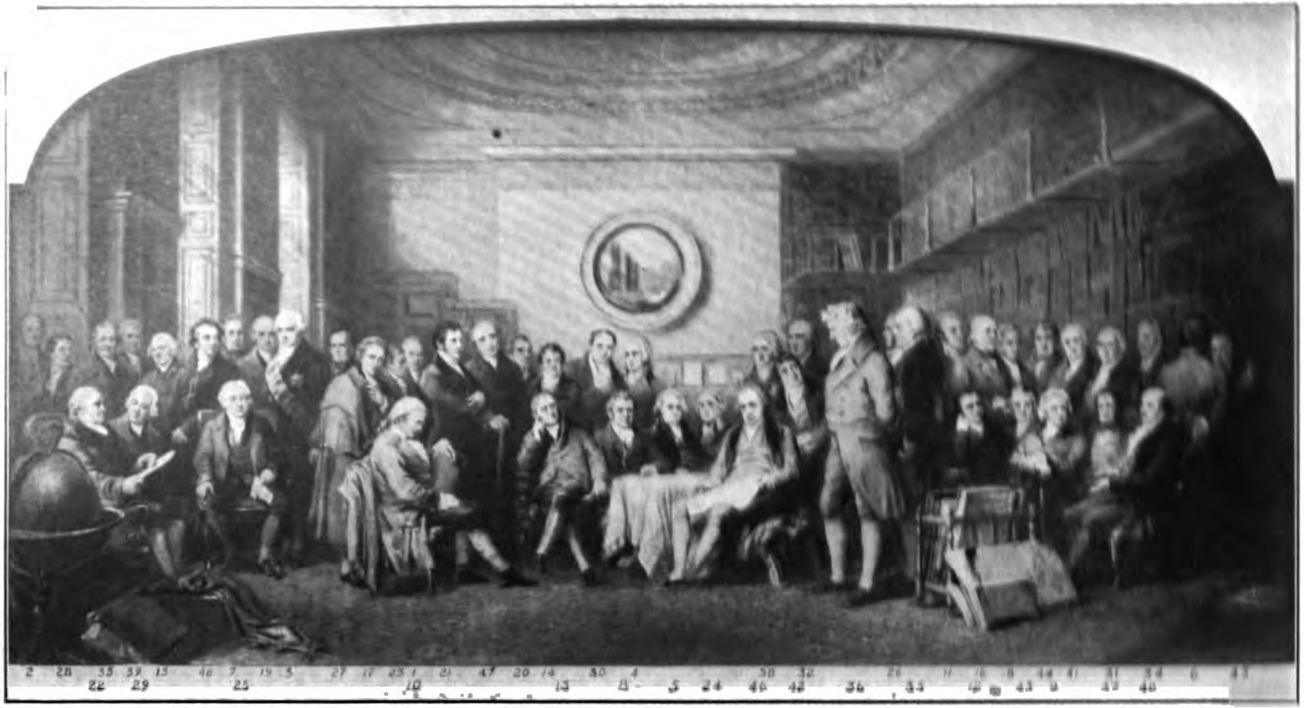
Mr. Charles H. Morgan was the engineer of the works, and had for his assistant, Mr. F. H. Daniels. These gentlemen greatly improved the system, and made it in every way successful. There were other forms of continuous rod mills, but the Worcester ones and those afterwards constructed at other works, based on the same lines, have been the prominent ones in America.

Perhaps the system of wire-rod rolling which has done the most to revolutionize the business, has been the Garrett mill. In 1882, William Garrett built his first mill for the Cleveland Rolling Mill Company, Cleveland, Ohio. Since then a number of others have been built in different parts of the United States, and their tonnage of production has been astonishing. These largely automatic (and therefore labor-saving) mills have rendered it possible to furnish the farmers with their cheap fencing, thus permitting the enclosing of acreage which under other conditions would have been impossible. Mr. William Garrett, himself a Scotch rolling-mill workman, came to the United States to take a job as roller in the works in which he afterwards was



GEORGE WESTINGHOUSE. BORN 1846.

His work in the invention and introduction of the air brake and of railway signalling apparatus alone has revolutionized the conditions of travel, and made possible an enormous expansion in the railway transportation service. His further work in the development of steam and electric machinery has exercised almost as great an influence in enlarging the scope and bettering the conditions of industrial employment



EMINENT MEN OF SCIENCE LIVING IN THE YEARS 1807-1808. FROM A GROUP IN THE NATIONAL PORTRAIT GALLERY.

The figures of most interest to the engineer are: 4, Sir Samuel Bentham, civil engineer and naval architect; 5, Matthew Boulton; 6, Joseph Bramah, machinist; 8, Sir M. I. Brunel; 9, Dr. Edmund Cartwright; 12, Samuel Crompton, inventor of the spinning mule; 13, John Dalton, chemist; 14, Sir Humphrey Davy; 16, Bryan Donkin, mechanical engineer; 17, Earl of Dundonald, naval engineer; 18, Henry Fourdrinier, paper maker; 26, William Jessop, civil and hydraulic engineer; 27, Henry Kater, maker of fine instruments; 30, Henry Maudslay, machine-tool maker; 31, Patrick Millar, inventor of paddle steamboat; 33, William Murdock, steam engineer and inventor of gas lighting; 36, John Rennie, engineer and architect; 37, Sir Francis Ronalds, inventor of electric telegraph; 38, Count Rumford; 40, Earl Stanhope, mechanical inventor; 41, William Symington, pioneer in steam navigation; 42, Thomas Telford, civil engineer; 45, Richard Trevithick, pioneer of high-pressure steam-engine; 46, James Watt. Photograph Copyright by Walker & Cockerell.

superintendent, and in which he put his first patented mill. He subsequently designed many other mills, and acquired large pecuniary reward. His death occurred in 1903. He too, was a forcible character. There have been many men engaged in the accomplishment of the great results which I have so briefly outlined. I have particularly mentioned some, not because they are alone entitled to credit, but because at least four of them can be classed as leaders whom any army would be proud to follow.

I have confined myself to iron and steel, but while their development may have been the basis on which other progress has rested, it must be remembered that in those other fields great work has been done. In fact, there is not a line of scientific and practical development on which the world has stood still; and where it has been a practical application of scientific knowledge, labor-saving appliances have always been part of the successful accomplishment.

Comparison of the general condition of the inhabitants of the United States at the beginning of the period covered by my narrative, during that period, and now, will demonstrate that there has been a progressive improvement, and that the standard of living has been raised. If the spirit of unrest has also increased, it is because the people have learned to want more, because it has become possible to have more. No great economic changes of any kind can occur without inconveniencing some one; but if by such disturbances, the many gain at the expense of the few, the ultimate result must be for the good of all. It may be hard lines for the time on the few, but let us remember that a patriot declared ages ago: "It is sweet to die for one's country." Of course so dying did not take away the pangs of dissolution, but there was a satisfaction of duty done, which made even death welcome. So instead of bewailing conditions which may for the time seem to be against our particular case, remember that such changes have been occurring since humanity existed, and instead of hopelessly repining, seek to see and take advantage of the way by which we too may be benefitted.

THE EFFECTS OF LABOUR-SAVING MACHINERY.

By Frank H. Rose

It is scarcely necessary to point out that unless the workman is willing to develop to their best the labour-saving powers of the machine he tends, the genius of the inventor has been spent in vain. The early history of the use of machinery is one long record of the workman's bitter and violent struggle against its adoption. This was followed by the still lingering trade-union effort to limit production, which was merely a newer form of the same false idea. But the growth of mechanical production has been scarcely less remarkable than the growth of the horizon of the better class of labour leaders. Mr. Rose is an exponent of the best and most influential element in British trade-unionism, and his position as defined in the following paper is characteristic of the modern British labour party. It would be difficult indeed to frame a sounder economic philosophy than Mr. Rose professes, or to argue it more ably. The country whose workmen are guided by such counsel as this need fear little from any industrial competitor.—THE EDITORS.

IT would be affectation on my part to deny that my sympathies are with my class. No amount of sympathy, however, can bind me to facts which the most casual student of British industrial history can find lying upon its surface. In dealing with so important a subject as the present, a writer must divest himself of those prejudices which are too frequently associated with class advocacy. For my own part, I am seriously trying to examine the question in a purely non-partisan spirit, and with a desire to exhibit truths rather than to ventilate opinions.

Machine appliances have revolutionised every industry; but in almost every case their best results have been minimised and their natural development impeded—either by the workmen's hostility, or the employers' narrow conception of their possibilities. The most ardent defender of trade-union methods would insult his own conscience by pretending that a heavy share of culpability is not associated with the workman himself.

I am frankly taking the position that machine appliances are not only blessings in themselves, but are the source of manifold benefits to all men. In considering the question I shall have to deal with the "Effects of Labour-Saving Machinery" in its broadest sense, and not merely as it affects my own trade; for antagonism to machinery is not peculiar to operative engineers. Whenever in the history of labour in Great Britain we find manifestations of the workers' opposition to the machine, the root cause is the same. There is no essential difference between the anarchic excesses of the old Luddite, and the subtle method of the modern "reluctant." In one case the hated machine is destroyed; in the other its benefits are sterilised. I am more anxious to find an explanation for this folly than to invent an excuse for it. It undoubtedly arises from a fundamental misconception. The "Luddite" method may be taken as far more defensible than any form of "ca' canny." To the uneducated operative of the early part of last century, the machine was a malignant and insatiable monster which had already devoured his brother and would devour him in turn. He had none of the evidences before him of the benefits which have come to the world as the result of machine processes. The machine was apparently a device of his immemorial enemy to starve him and to slay his calling. He acted upon the first impetuous impulse of ignorance and hatred, and took the impotent course of trying to wipe out his foe by violence.

In front of the workman today are all the vivid proofs of the uselessness, as well as the mischief, of resistance to the inevitable. However unpopular may be such a declaration, I know that no honest enquiry into this question is possible which does not take cognisance of the prejudice which still exists in the workman's mind against new appliances for increasing labour's productivity. Whatever may have been the outward manifestations of this prejudice, their results have been uniformly mischievous, and consistently productive of strife and waste. Yet the growth and development of the machine system is as certain and remorseless as death. No attempt to resist it has ever been crowned with even a temporary success.

Having said so much, I shall be acquitted, I trust, of any desire to colour this article to suit the worker's taste. As an active Labourist with twenty-five years of trade-union effort to my record, I have felt that my own experience enabled me to speak with some degree of authority. In this case, however, I have been at some pains to supplement my own knowledge with the testimony of leading employers and workers. Taking as a basis of enquiry the candid admission that the prejudice against machinery *does* exist, I have tried to determine its present intensity and influence. From every person I have consulted comes the evidence that the prejudice is passing, however slowly, away. We Britishers are proverbially slow to learn. A natural reverence for tradition makes us cling to many fallacies, not because they are fallacies, but because they are hoary. But it would be strange indeed if even British workman were unmoved by the accumulating evidence of the folly of resistance to the inexorable development of machinery, or the equally unevadable proofs that it has brought a blessing and not a curse.

The policies of the great labour unions are conceived and carried out in a spirit of tolerance and concession towards labour-saving appliances. This would be impossible if a more tolerant spirit were not prevalent with the membership. In spite of all that is said to the contrary, the policy of a "council" is the reflex of the sentiment of the members. Hence it is that in the engineers' unions the "machine question," which for years was the prolific source of dissension and conflict, has practically ceased to trouble. Though the old delusions linger, the consciousness grows that the machine has come to stay and cannot be pushed out. As a result we have the first happy indications that the only rational way of dealing with the machine is to make the best of it. The employers' representatives to whom I have spoken generally admit that the workers are more amenable now than formerly—even recently—and that their own workshop administration is interfered with in a constantly lessening degree by disputes about machinery. I should be glad to be able to say that the old evil is extinct. But I am glad to say that it is perceptibly yielding to a more enlightened and hopeful state of mind.

The British employer, on the other hand, is neither a blameless saint nor a suffering martyr in connection with this question. While he has hung onto his old-world methods and beliefs, he has been forgetful of the fact that the workman's prejudices are more the results of heredity than deliberate ill disposition. Nor has his conception of the machine been one whit more liberal than that of his employee. The machine, I fear, has been regarded less as an agent for increasing labour's value and productivity than as a convenient implement for curtailing labour's reward. The unity of interest between capital and labour has long done duty as a pious opinion—even as an abstract economic proposition. But when we translate "capital" into "capitalist" and "labour" into "labourer," the unity of interest ceases to have any force or value. There is nothing so certain as the fact that so long as capital works for profit and labour for wages, both will work for their own ends with more or less disregard for each other's interest. The machine appears to me to provide a medium by which both ends may be served if both parties will settle down to make the best possible use of it. We may leave the allocation of blame due to employers and employed respectively an open question, but we have to admit that, whoever deserves the larger share, the machine so far has not had a fair field for its natural development in Great Britain. Yet, in spite of this, the benefits it has conferred are almost incalculable. I cannot trace a single social or industrial evil to its use. I can trace many to its misuse. I regard the machine as the first potential of all the material progress of our age. I am in favour of a frank recognition of its virtues by the workman, and of his endeavour to get its best results. If any words of mine will tend in a remote degree to remove what lingers of the old and stupid fallacy that "Machinery murders Labour," I shall not have written in vain.

The Effects of Machinery on Wages.—I have frequently said to English engineers that there is but one labour question—the question of wages. Whatever complexities we discuss as industrial topics, the question of wages or reward is the one we find ourselves returning to in the end. The only incentive to work is its reward. We occasionally hear of pure-souled and unmercenary persons who need not work, but who do work because they love work. These are valuable communal assets as they serve as shining examples to the rest of us who are fashioned of common clay. There are not many of them. The operative has no other object in working but his wages. If it could be proved that the use of machinery increased his wages, his objection to it would be removed. I do not think that the introduction of labour-saving appliances has had the effect of increasing the *amount* of wages in the country. What it has done has been to increase the purchasing power of a man's wages. Comparisons between wages paid to hand workers fifty years ago and wages paid to machine workers in the same industry today are worthless. The textile trades are those in which this comparison is the strongest. But wages have been raised and maintained by the action of the trade unions, and with or without highly developed machine systems of production, the rule holds good that the best organised bodies of workers are the best paid. What machinery has done has been to cheapen commodities of daily use and so to raise the actual labour value of operatives.

On Hours.—Here again the advantages resulting from machinery are of an indirect character. The long hours prevalent in the middle of the nineteenth century were due entirely to the lack of power of the workers. No conceivable development of machinery would have any effect in the direction of shortening hours. I cannot find that machinery has increased either the worker's wages or his leisure. But it has enlarged his opportunities for the profitable use of both. It has given him cheap and rapid transit and has enabled him to engage in pursuits and to cultivate tastes which would have been inaccessible without its aid.

On Volume of Employment.—It is in this particular that the effects of labour-saving machinery have been the most pronounced and the most beneficial. It is singular, too, that, though the evidences of this are the most obvious, the worker still regards the machine as a rival and an enemy. The fear is based upon the grotesque hallucination that there is only a certain amount of work to do in the world, and that if machines are employed to do it there will be no work left for the men. It finds its parallel in the crazy "wage-fund" theory of the old economists which set up the preposterous proposition that there is but so much wealth available for labour, and that a rise of wages in one trade or locality must inevitably be followed by a corresponding decline elsewhere. Time and better sense have exploded the "wage-fund" doctrine, but the other and more pernicious fallacy is with us yet. All the facts are against it. Machinery has increased the volume of employment in every trade, doubled it in most, and multiplied it indefinitely in many. It should be superfluous to quote examples. The case of the textile trades is too familiar to need elaboration. The evils which followed the early introductions of power appliances were due not to the use of machines, but to their abuse by callous factory lords in a hurry to get rich. More apposite and more modern is the comparatively recent revolution in the printing trade. The introduction of the linotype was vehemently resisted by the operatives. Then, as ever, resistance was impotent. The thing was there and has stayed there. It was to kill the hand "comp," and to extinguish the printing industry. It did neither. It created a new calling. It widened the possibilities for employment of those already engaged in newspaper work particularly, without lessening either the importance or the possibilities of the printing trade generally. I do not propose to enter into a justification of the thousand and one peculiar publications for which this revolution in the printing trade is responsible. I am treating the question from the utilitarian rather than the ethical or intellectual standpoint. My point is that the world is richer and the worker no poorer as a worker. As a citizen and a consumer, he is better off with the machine than without it.

On the Standard of Material Comfort.—A race of men and women who wear machine-made raiment, eat machine-made food, and shelter in machine-made houses, need not quarrel with their universal provider. To say that there are just as many naked, starving, and homeless people as ever is no answer to those who assert that the machine has enormously raised the standard of material comfort for the people. Machines will not settle social problems. Acts of Parliament devised by pure and inspired legislators fail sometimes. The man who has no penny is always with us, but the machine has not made any more of *him*. The machine has enabled the man *with* a penny to get for his penny a bigger or a better something every time. If the machine gives us better penny-worths without diminishing our opportunities of getting pennies, the machine must be a benefit. I am not attempting to speak for lands I have never seen, or people I have never known. But I have known something of working-class life in England for the last thirty years at least, and I say fearlessly that the standard of material comfort has risen enormously. With equal confidence I attribute the betterment to machine production. Wages have never risen to an extent which accounts for the difference. In the matter of food it is fashionable just now in this country to ignore the machine as a factor in cheapening the people's bread. But this is the way of politicians. If the crop of a big western farm had to be sown or reaped by hand it would make a bigger difference to our baker's bill than a good many "fiscal reforms."

Our clothing is a machine product from the raw material to the finished garment. We are better dressed than our fathers and there are many more tailors. But in our homes—I speak of workers' homes—the difference between what was and what is, is even more marked. There are a hundred objects common to worker's homes today which were unheard of, because unattainable, in my boyhood. From the child's toy to the pianoforte in the parlour, the items which make up the home now are better and brighter than those our fathers had. Machinery alone has cheapened them into accessibility.

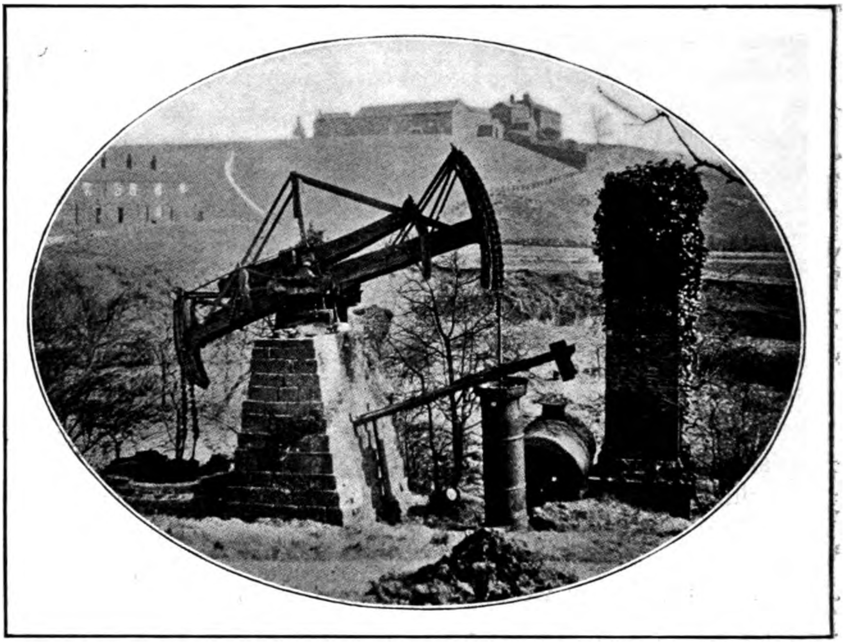
On Mental and Moral Development.—Mr. Allen Clarke, in his clever little book, "The Effects of the Factory System," draws a pathetic picture of the mental degeneracy of the textile operatives of his native town, Bolton. Allen Clarke is a name highly and deservedly honoured in the labour world, but his reasoning is not always beyond criticism. He attributes the mental deterioration of his towns-men to the monotony of their occupation, and sighs for the good old time when machines were not. Granted that a life of days of unvaried occupation is dementalising, how would the substitution of hand work for machine work improve matters? The production of thousands of articles or details of articles by hand is surely as monotonous as the production of millions by machine. Hand knitting, hand weaving, hand spinning, offer no more variety than the same operations by machinery. To suggest that machine methods induce mental deterioration is wholly unjustifiable. Repeated operations of any sort are monotonous, but certainly not more so when performed by machine. Rivetting, for instance, is not an occupation which calls for close mental effort, but I can easily believe that a man operating an electrical rivetter has as much interest in his work as though he was closing and snapping his work by sheer muscular effort. I am confident that every repeat operation in the whole industrial world is as interesting now, as ever, to the workers whose lot it is to perform them. Industrial skill and intelligence are just as requisite in a world driven by machinery as in one impelled by manual force. I am certain that I was as interested in my work when a machine planed my timber in a well organised pattern shop as when I had to spend days in "strapping up." Machinery has detracted nothing from labour which gives it interest or stimulates thought on the part of the worker.

The development of highly organised machine systems has induced a sense of order and personal self respect which manual occupation would never bring about. If, in large factories, it has led to a mingling of the sexes, the results are not evil. The unmitigated abominations of the factory system in the early part of the last century have no parallel in our time. The contact of the sexes in our modern system leads more frequently to marriage than to intrigue. The higher the development of the machinery, the better the condition of the factory and the less the dangers of the horrors which provoked the justified denunciations of Sadler, Oastler, and Shaftesbury.

On the Relations of Labour and Capital.—I have previously expressed the belief that, under our present system, the unity of labour and capital is an absurdity and a delusion. It does not exist. The struggle between wage earners and wage payers is as natural as any other struggle in the material world, and will go on in spite of any shifting of venue or alteration of method. But machinery has reduced its virulence and softened its acerbities. The machine has been a better peace maker than either the man or his master. The most effective illustration of this will occur to all who followed and still remember the engineers' lock-out in 1897. One of the terms upon which it closed ostentatiously paraded the fact (never disputed) that "the machine tools are the property of the employer." The employer therefore claimed the sole right of using them as he liked, of appointing whomsoever he pleased to work them, and of paying any wages for the work that seemed good to him. This gratuitous humiliation to the defeated worker was bitterly resented. The smaller spirits on the employer's side laboured it with provocative arrogance. The hot-headed section of the man vehemently denounced it, and but for the restraining influence of their leaders would have made it the *casus belli* of another revolt. Wiser counsels here prevailed on both sides, and though the clause still stands as part of the mutual arrangement between the Amalgamated Society of Engineers and the Employers' Federation, an extreme conception of its meaning and scope is never urged by either side. The machine tools are still the "property" of the employers, but the skill and experience of the worker is also a "property" equally entitled to recognition and consideration. It is true that almost every newly introduced appliance provokes dispute or necessitates the rearrangement of terms and conditions, but with the passing of mutual prejudices the difficulties of adjustment have appreciably diminished.

On Physical Degeneracy.—It is no part of my present duty to discuss this terrible phase of modern civilisation in its political or social aspect. To whatever cause our physical deterioration is due, its facts are incontestible. The recruiting statistics in connection with the British army tell a tale that no optimism can explain away. Fifty per cent. of Britain's young manhood in industrial centres is not good enough for her army. It is not merely that the body is shrivelled and the faculties dulled. Incipient consumption, ophthalmia, and other diseases are added to shrunken frames and deformed limbs. Deeply as this race tragedy appeals to me, my only concern with it here is to inquire how far this evil is traceable to machinery. It is a common and plausible theory which attributes this deterioration to the "factory system." As the "factory" era in our industrial history began and has developed with the introduction of machinery, it seems easy to trace the biggest and worst evils to it. The essential fact that is lost sight of is that the horrors of the early years of the "factory" era arose, not from the use, but the misuse of machinery. The callous greed of the old factory lords was uncurbed by any legislative or trade-union restriction and is blameable as the genesis of the workers' physical decay. But to argue by a sequence of propositions that machines made the factory system, the factory system made the slums, and the slums have produced the physical degenerate, is illogical and untenable. The influence which transformed the stalwart yoemanry of Lancashire into a race of stunted weaklings is assuredly not that of the machine. It is outside the scope of this article to examine such questions as those which arise from a consideration of the most imperative English social questions of our time—the problem of the bad housing of the poor. I am convinced that to bad housing chiefly our physical decadence is due. However, machinery has multiplied, the organised worker has consistently improved in health and longevity. That the improvement arises from better sanitation and a better standard of living is quite true. It still leaves a vast and terrible residuum of our population a long way below the line which divides comparative prosperity from destitution. We have already seen that machinery does not increase poverty by deforcing labour, nor does it accentuate physical deterioration. Wherever its use is the most perfect and efficient, it brings lighter and healthier workshops, better surroundings, sanitation and hygiene. It effaces the perils of many of what are or were known as dangerous occupations. Nobody can visit the Diamond Match Works at Bootle without being struck with the immeasurable superiority of the machine system of producing such simple and essential articles as matches. Machine processes enable us to produce them in millions without the touch of a human hand, and the perils of "phossy jaw" are horrors of the past. No less remarkable is the pneumatic device by which anthrax in the wool-sorting trade is obviated in the best equipped factories in Bradford. In every case the rule prevails that machinery is in itself an unmingled blessing. Its abuse, like the abuse of every other blessing, brings retribution. No man can trace a single glaring wrong or evil to machinery. Physical deterioration, of all others, is the least attributable to machinery. Machinery has brought health to the workshop and comfort to the home. If it has not removed the social anomalies of our time, it has certainly not emphasised them.

Science has not spoken her last word. The machines which fill us with wonder and admiration today will be primitive and ridiculous tomorrow. The duty of the worker, no less than his personal self interest, dictates the whole-hearted and unreluctant acceptance of whatever "labour-saving" devices the inventive faculty of man can produce. The British employer will have to revise his code as well. If the workman is to rise to truer conceptions of labour's duty to the community by getting the best results from his employer's "property," the employer must offer the incentive. In Great Britain the best worker is ground between the "minimum" of the Society and the "maximum" of the employer. There is no room between them. During the past few days a representative employer has tried to convince me that the whole mischief in the engineering trade is due to the arbitrary and fatuous rule of a "minimum wage." It reduces all men to a dead level and, but for it, I am told that employers would gladly pay according to merit. But the minimum wage is nothing but a limit fixed by the men, below which no man shall work. In this country its highest mark is 40 shillings for 54 hours and in many places it falls below 30 shillings. These figures, which do not take account of a very recent reduction, do not strike one as exorbitant. There is surely room above this to reward special merit, skill, and industry. Special rates of remuneration are rare in Great Britain. The special recognition of special work is an exception, not a rule. That the man should do his best with his machine and the employer his best with his man is an honest and sound principle. Unhappily, it is true that neither party does his best, and, as a result, the machine suffers in proportion, while the country suffers in wealth and reputation. Machinery in any of our great industries has never yet had the effect of devitalising the worker's energy or the employer's enterprise. There are no ruined industries, impaired prospects, or vanished interests to be laid to its account. It is the duty of the worker to get its best results by his own effort. It is the equal duty of the employer to recognise that effort with the highest reward.



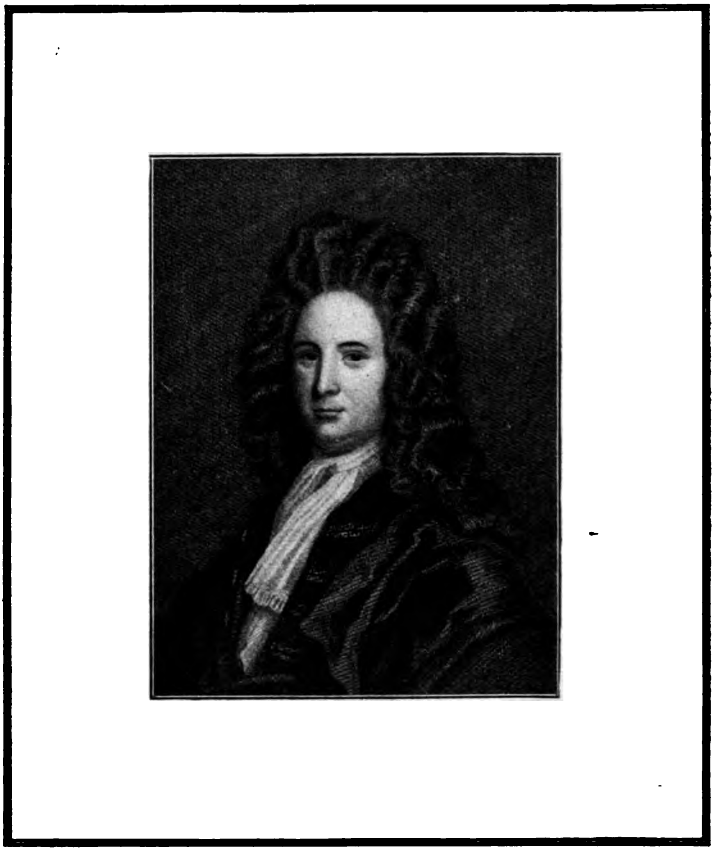
NEWCOMEN PUMPING ENGINE, BARDSLEY, NEAR ASHTON-UNDER-LYNE.
OUT OF USE 1830.
• **From Mr. Henry Davey's paper before the Institution of Mechanical Engineers.**

THE PRIME MOVER AND ITS INFLUENCE ON THE WORLD'S PROGRESS.

By John E. Sweet.

While "Production Engineering" is concerned mainly with the economical *application* of power, the basis of the mechanical expansion of the last century is the economical *generation* of power. The prime mover must come before the power-driven tool. We are happy in having this short survey of the rise of steam power, from one who has been a living factor in much of the later and finer development of the steam engine.—The Editors.

MAN can make no material thing without the aid of a tool, an implement, or a machine. In the beginning it is presumable that he made a maul of a stone to crack a nut; it was the embryo hammer, without which man could exist only by living upon roots and herbs and fruit, and civilization could never have been. From the beginning man has been striving and scheming to make things easier and more comfortable for himself. He brought wind and water and fire to his aid. With his stone hammer he struck fire from the rock; with fire he smelted his ore, and softened his metal out of which he shaped his tools and became the tool-using animal. With his tools he carved out his skiff which the wind wafted over the seas; constructed carts and trained the beasts to carry his burden; built his mill which was turned by falling water, and later when water was scarce the wind turned the mill.



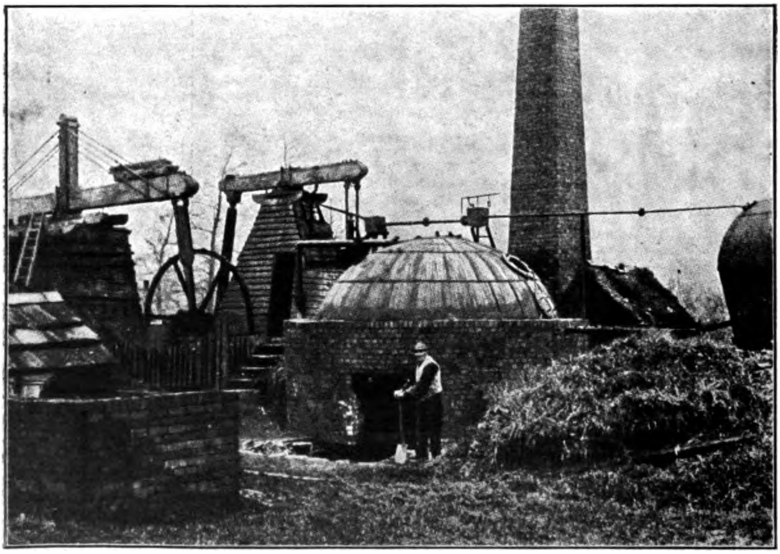
CAPTAIN THOMAS SAVERY. 1650-1715.

The immediate successor of the Marquess of Worcester in the work of developing the steam engine, and the first to "put in practice the raising of water by fire." The model of his "Miner's Friend" was exhibited before the Royal Society in 1699, the year after his patent was granted.

Man was made to labor, but none of these things was made by labor alone. The material, the tools, the labor, and above all the intelligent guidance of the inventor, were necessary for the production of the least of these. Man devising things for his comfort devised things for his protection—protection against wild beasts, and protection against the depredation of his neighbors; so his implements of protection became implements of war, and then, as now, the man and the nation that provides for war has war, and the history of the world as it is is the history of wars. The heroes who live in history are the warriors, and the memory of the men who made the things that contributed to the comfort and happiness of mankind, much too soon passed away.

Aside from that carried by the beast of burden and the boats on the rivers and seas, the moving of masses was by the aggregation of human hands. The mills and the ships, the palaces, monuments and prisons were built by the guided multitude. For centuries upon centuries this was kept up. In the Egyptian age, the age of granite, millions of days' labor went into the tombs and temples. Greece with her architecture and sculpture was the work of the hand and chisel. Rome was built by the sweat of the brow, and her paintings made on hand-made cloth; up to the eighteenth century man had only the crudest of tools, scarcely any machinery, and but the wind and the water to second his exertions.

Hero discovered the power of steam, but used it only as a toy, and it was nearly two thousand years before others proposed to put it to



BASSET ATMOSPHERIC ENGINE, DENBY COLLIERY, NEAR DERBY.

Erected in the position shown in 1817, having been in use previously at another pit. Dismounted 1866. From Mr. Henry Davey's paper before the Institution of Mechanical Engineers.

OLIVER EVANS. 1755-1819.

From an engraving by Jackman. By courtesy of Messrs. Wyman & Gordon, Worcester, Mass.

His life is a pathetic record of struggle and poverty, in spite of far-seeing genius and high inventive skill. His millwright inventions revolutionized the milling industry. He was a pioneer in the design of conveying machinery and in steam road locomotion, and the earliest advocate of the high-pressure steam engine.

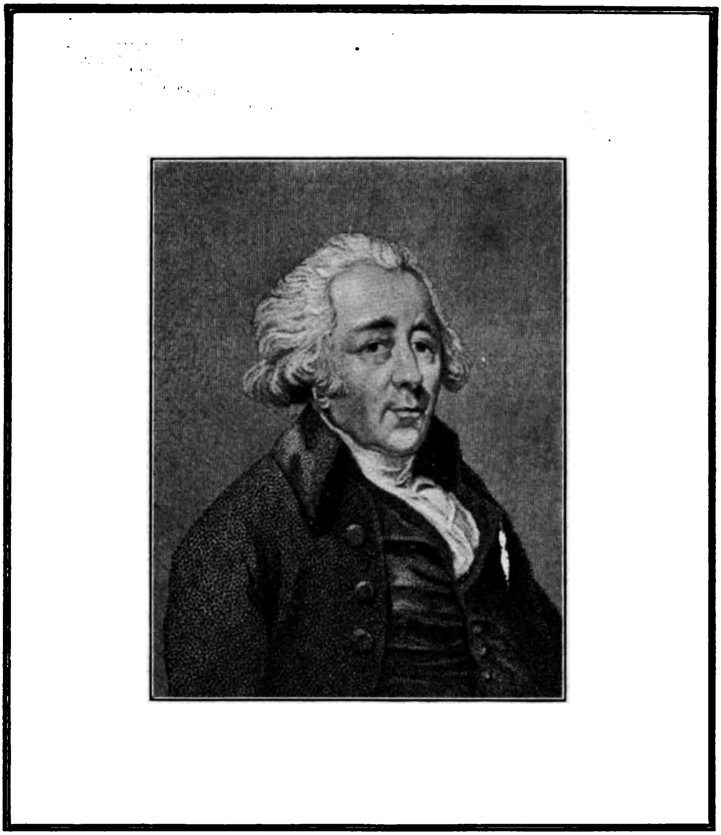
use. Here and there suggestions and models were made, to die out; and the world went on with hands and tools making what they could, and the nation that had the most tools and the greatest intelligence advanced the most rapidly. Slowly the skiffs grew to boats and the boats to ships, built by hand and controlled by hand. The carts grew to wagons and stages, the roads were made better, animal transportation became general; the water wheel was made larger and more efficient; the wind mill grew from a toy to a machine, and the mills grew in size, but only by the slow growth of centuries. At the best they relieved only a fraction of the human drudgery; and in what aid man had from nature's powers there was no means of transmitting its energy—the horse and the load, the wind mill and the pump, and the factory and the water wheel went together.

Newcomen advanced farther than others had before him by constructing some working steam engines, but not until the last half of the eighteenth century was much done to meet the wants of an enterprising people. Although use had been made of the then available forces, after the advent of the steam engine they were made more available. The mind of man had reached its limit centuries before in mathematics, literature, philosophy, and poetry; sculpture and painting had been brought to as high a pitch as now, and undeveloped invention had shown flashes of light; but not until the work of James Watt gave new life to industries and pushed ahead the century of invention had there been any such advance towards relieving human efforts as followed.

Matthew Boulton, the partner of Watt, in conversation with King George III, was asked "In what business are you engaged?" and he replied, "I am engaged, your Majesty, in the production of a commodity which is the desire of Kings." "And what is that? What is that?" asked the King. *"Power,* your Majesty," replied Boulton; he might have said "I have what all the world wants, and I have what will do more to help relieve the laborers of the world, and I have what will do more to advance civilization, than ever has been done, and more than will be done in all other ways for the next two hundred years."

What material thing is there in sight, what human achievement, what is there worth having that has not behind it, or connected with it in some way—the steam engine?

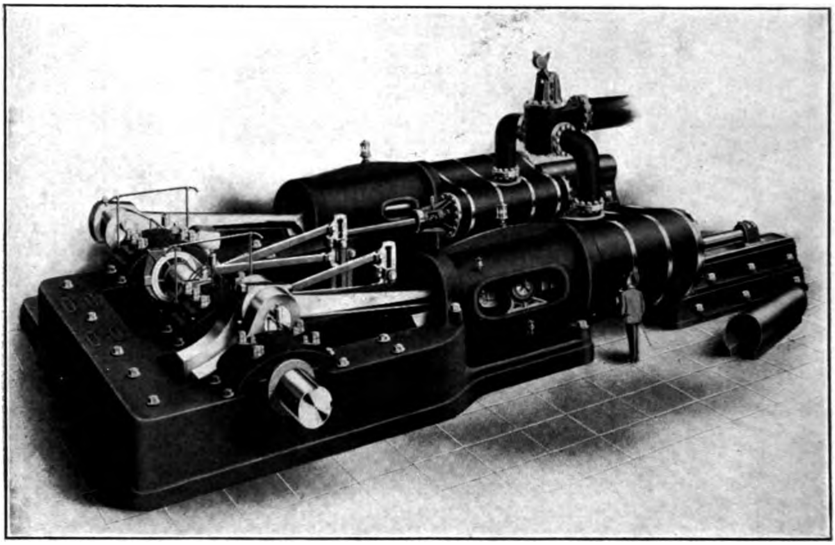
When the marvels of the steam engine are mentioned, we instinctively associate it with the great ocean steamers with their 10,000. 15,000, 30,000 horse power; with the great electric power stations, the rolling mills, and blast furnaces; but there is not a thread in the clothing we wear that has not been carded and twisted and spun and transported by the power of steam; not a spool, a needle, or a pin but, many times over, the steam engine has been prime mover in the various operations of its production. Steam has so outgrown other natural powers and gone so marvelously beyond all other artificial powers as to be the one thing that has revolutionized all forms of human endeavor. But a century ago the aid given to human labor by nature's forces was a small part of the whole; now human effort supplies but a trivial fraction of the energy employed for useful purposes.



MATTHEW BOULTON. 1728-1809.

The partner of Watt, by the acquisition of the interest in Watt's patent formerly owned by Roebuck. Much of the practical success attained by Watt's inventions was due to the intelligent, broad-minded, but discriminating support afforded by Boulton's business ability and financial backing.

Fields are plowed and cultivated, crops planted and harvested, grains transported and ground, and flour kneaded by generated power. Timber is cut and sawed to dimensions, planed and framed, shaped and moulded and sand-papered; house-joinery and furniture is made by machinery; the crockery, the glass, the silver-plate, cutlery, toilet articles, bric-a-brac, and matches—all have the steam engine back of them. Building stone is quarried, transported, sawed or planed, and carried to its place in the building. Monuments are cut and polished, statues carved, bricks made, carried, and hoisted to their place; mortar is mixed, wood-work painted, builders' hardware made; iron ore is dug, lifted by steam cranes, conveyed to the top of the blast furnaces, smelted and pigged or blown into steel, cast or rolled into blooms, billets, beams and bars, sawed to lengths, cut and shaped and punched, bent and riveted; worked into ships, buildings, bridges, and boilers, engines, machines, bolts, rivets, wire, nails and brads—and all by the aid of the steam engine. By steam, harbors have been dredged, canals dug, tunnels made, docks built, steamships made to traverse every water on the globe, railroads to traverse every country. One may go to the Pyramids, up the Nile, to the pinnacle of a dozen mountains. Railroads traverse our plains, cross and re-cross India; one may ride in Africa and Alaska, go from Spain to Siberia, from Maine to Mexico; diamonds are mined in Kimberley and gold washed out in Alaska; jewels are cut and money coined; paper, ink and books made—in fact, not only every material thing we see and use, but the immaterial—electricity, light, power, and even heat—are made by steam power. The electric telegraph is worked, our houses and cities lighted and the map of the country is cob-webbed by lines of street-car roads where the steam engine is the prime mover; and all these wonderful changes have been wrought in five quarters of a century.

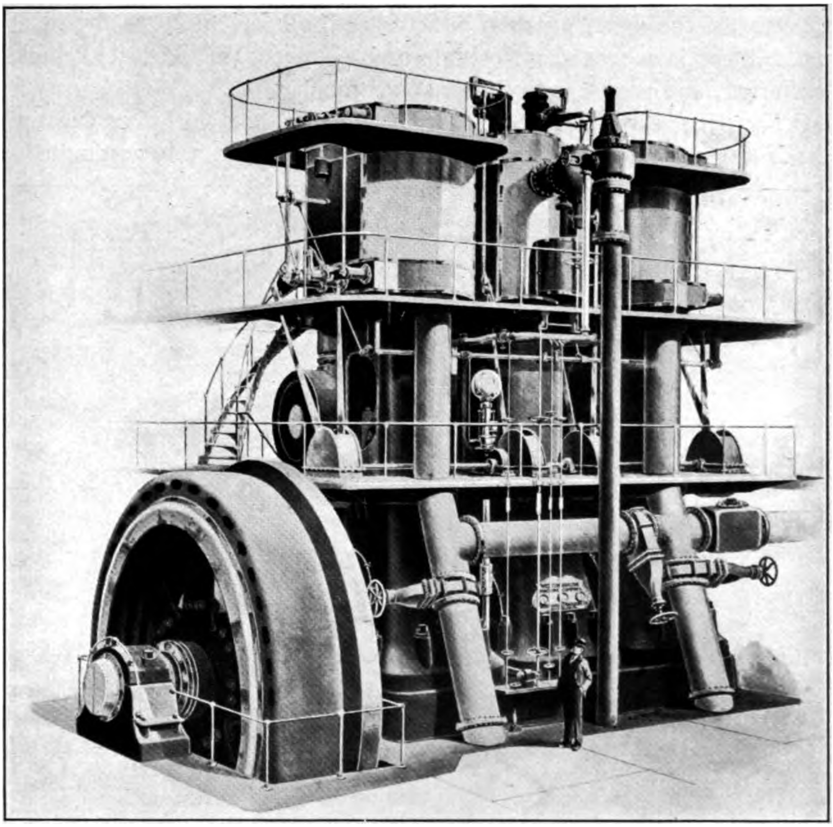


THREE-BEARING REVERSING ROLLING-MILL ENGINE.

A product of the demand of the modern steel industry upon steam power. 54-inch cylinders, 66-inch stroke; weight of one bed casting, 86 tons; built for Lackawanna Steel Co. by the William Tod Co., Youngstown, Ohio.

The steam boat has grown from the Clermont to the Celtic in a century; the locomotive from the Rocket to the mountain climbers, in three-quarters of a century, and the street-car lines in a quarter. I have seen both a Newcomen and a Watt engine running, and there is one of the latter still running in Birmingham; I have seen the railroads, telegraph, electric lights and electric railroads come into existence, and then wonder what can steam do more. No! not what can it do, but what can it not do? If the steam engines of today were hitched to a star and set to pulling back on the earth, our days and years would be lengthened and perhaps the harmony of the universe upset.

How futile it would be to attempt to do by manual labor the work performed by the steam engine! An ocean steamer of the Lucania class is propelled by a force of 30,000 horse power; counting 6 men to



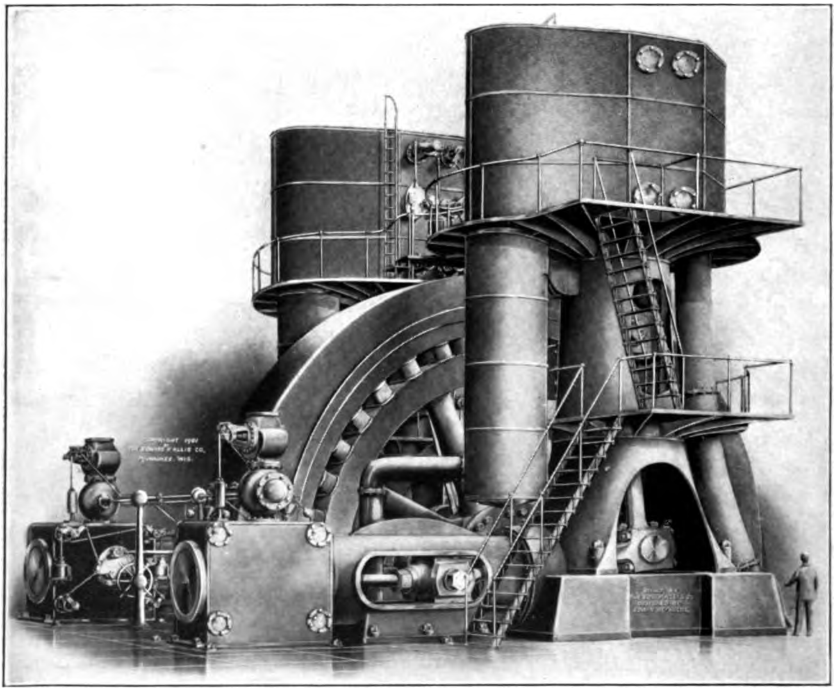
WESTINGHOUSE THREE-CYLINDER COMPOUND STEAM ENGINE, NEW YORK EDISON CO.

One of eleven units in station. Poppet valves on high-pressure and Corliss valves on low-pressure cylinders; cylinders 43½, 75½, and 75½ inches, stroke 60 inches; 75 revolutions; 7,500 maximum horse power. Floor space 40 by 29 feet, height 34 feet.
Westinghouse Machine Co.

the horse power and three shifts every 24 hours, the mere driving of the ship would call for 540,000 men; and if such a vessel could carry 10,000 men and their provisions it would be only 1/54 of the size necessary to carry its own motive power. Without steam our present ocean service could not be, nor could one of our passenger trains carry a sufficient number of human laborers to propel itself at present speeds and continued service, to say nothing of the freight; and the same computation will show that the entire working force of New York City could not do the work of the one single 80,000-horse-power plant recently built to supply the elevated railroads of the city.

The heat engine, steam, and its offspring—gas—are doing three-fourths of the world's work; and where the heat engine is the most used there is where the world is best civilized and where idleness, suffering, and poverty are the least common.

For fifty years the best engineering talent of the world has devoted itself to reducing the waste of fuel in generating steam, to accomplish-



REYNOLDS COMBINED VERTICAL AND HORIZONTAL ENGINE.

Built by the Edward P. Allis Co. (now the Allis-Chalmers Co.). Designed to operate at 8,000 horse power as the most efficient load, and capable of a continuous output of 12,000 horse power. Type designed for the elevated railroads of New York City.

ing the more economical use of the steam in the steam engine, and to developing a better use of the fuel by converting it into gas and using it in the gas engine. So successful has it been that probably five times the work is done with the same amount of coal that was done fifty years ago; and yet twenty-five years ago, when nearly twice as much coal as now was used for the same work, the best engineers thought they were near the limit. In view of the continual advances, he would be a bold man who would say we have come to the end!

At the appalling rate we are now exhausting our coal supply, it would seem as if that would stop the steam engine; but as it has been shown that the otherwise unavailable land of the world will raise one hundred times as much fuel a year as we now consume in a year, there would appear to be no end of the heat engine, unless the available energy in the coal can be converted into electric energy—a thing some of the scientists consider doable in some untried way.

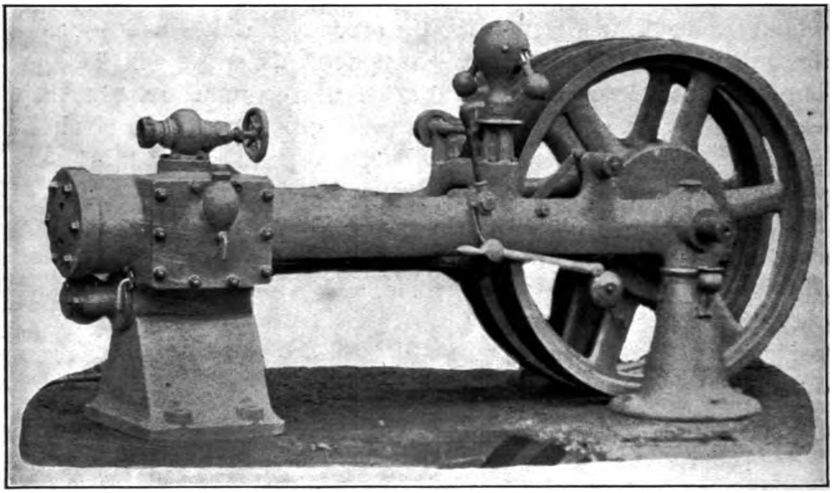
Different countries of seeming equal natural advantages vary greatly in their material prosperity, as is the case with Europe and Asia and North and South America; while the lack of the use of the steam engine may not be the cause of it, it is certain that the most backward could not have kept pace with the prosperous without availing themselves of the advantages of the artificial power.

The Doing.

In the beginning, boilers were made to carry only from 7 to 15 pounds, and in 1850 50 pounds was common practice. The pressure in marine boilers on ocean steamers was much less, and locomotives and river steamers seldom reached over 100 pounds. In 1880, return-tubular boilers seldom carried over 80 pounds, and engines were rated on that pressure. The water-tube boiler had just begun to make its way, and this opened up the field for higher pressures, leading to improvements in the return-tubular boiler, and to the development of others forms, until now it is common to find return-tubular boilers of 150 horse power running as high as 150-pounds pressure, and water-tube and internally fired boilers of the marine sort up to any pressure under which ordinary engines will run.

Flash boilers have been experimented with for many years—in the main, with common failure; they may do for torpedo boats and automobiles, but unless some way can be found to prolong their lives they will meet special cases only. As the case stands today, judging from numbers, the fire-tube, locomotive, the return-tubular horizontal, and the water-tube of the Babcock & Wilcox sort are the types in general use. The vertical boiler has fought a losing battle on the whole.

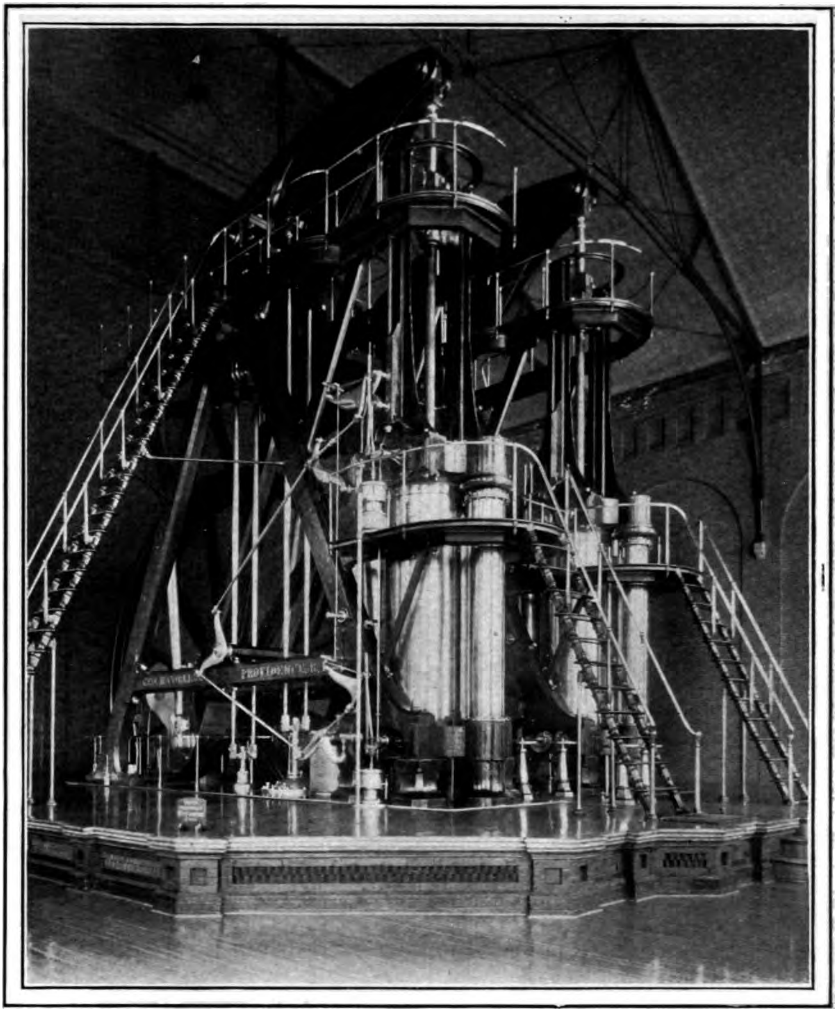
Furnaces and firebars or grates have received any amount of thought and experiment, and automatic stokers have been made of many kinds, with some advance in economy and a greater one in black-smoke prevention. Many of the most promising schemes fail because of its costing too much to make them work. One economical device which saved $15 a day in labor cost $40 a day for steam to run it, besides a good deal for maintenance, and like many another economical device, it cost too much.



THE STRAIGHT-LINE ENGINE OF 1871-1872.

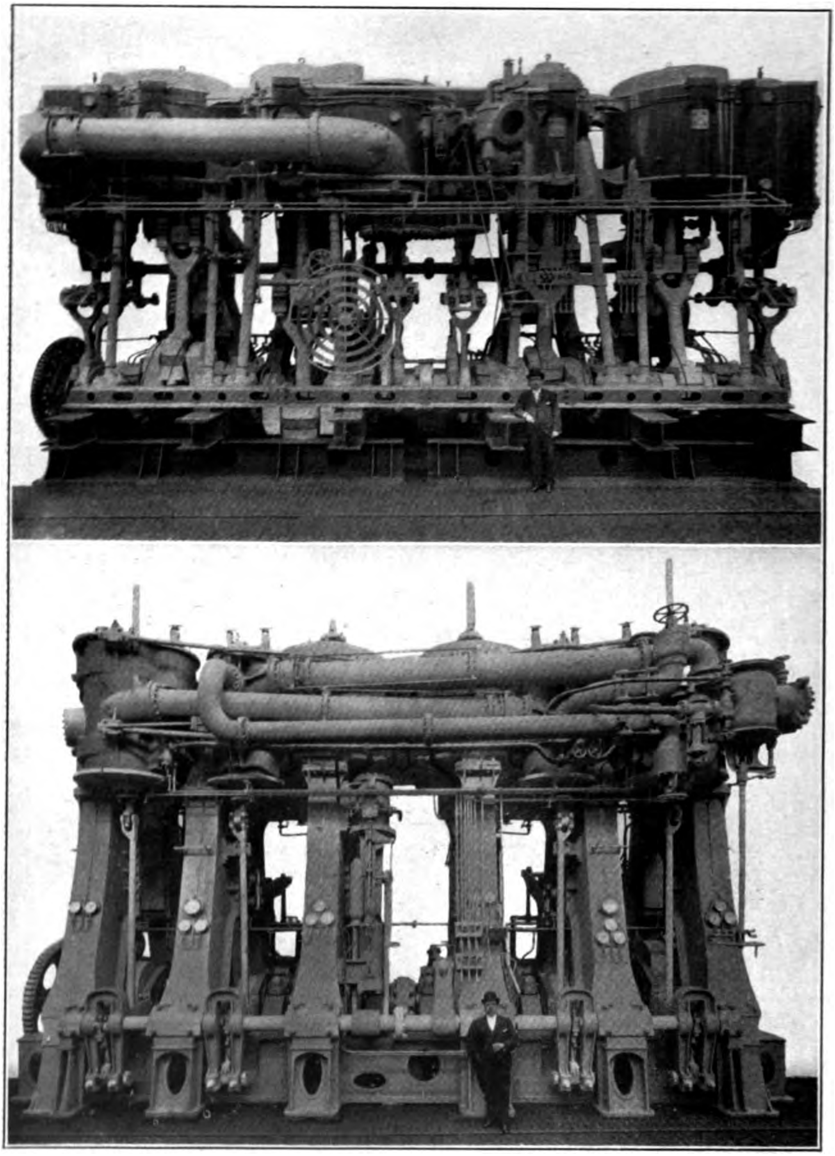
Altogether through the furnaces there has been considerable gain over early practice, and this has been by the use of better materials, better workmanship, and better designs—and more than all, by making it possible to use higher pressure. An enormous amount of heat has to go into water before it is converted into steam, and no practical way has as yet been devised by which this heat can be converted directly into work. After the water is converted into steam, then the more heat there is put into it the greater the percent. of the entire heat is available for work. It is the common remark that the steam engine is a wasteful machine, but why the unavailable heat that is put into the water by the boiler and the other boiler losses are charged to the engine is not apparent.

The steam engines of Newcomen and Watt originated out of the requirements for pumping; using a beam was exactly the thing to do, and it was not an unnatural, nor, in fact, a very bad thing to use when transmitting the reciprocating motion to a crank and converting it



THE HISTORICAL CORLISS ENGINE OF THE CENTENNIAL EXHIBITION,
PHILADELPHIA, 1876.
Now working in the shops of the Pullman Co., Pullman, Ill. This engine drove all the shafting in "Machinery Hall," and was the most prominent exhibit in the building, but *hors concours*. It consisted of a pair of beam engines working expansively at 80 pounds; cylinders 40 inches, stroke 10 feet; beams 27 feet long, 9 feet deep; flywheel 30 feet diameter, 2 feet face, weight 56 tons—probably the largest cut-gear wheel ever made. 36 revolutions, 1,400 horse power with a maximum of 2,000. The illustration is presented by the courtesy of the Allis-Chalmers Company.

into rotative motion under the conditions existing at that time. The beam engine held its own for years after the crosshead plan came into use; in fact, it has hardly gone out of favor yet. Mr. Corliss used the

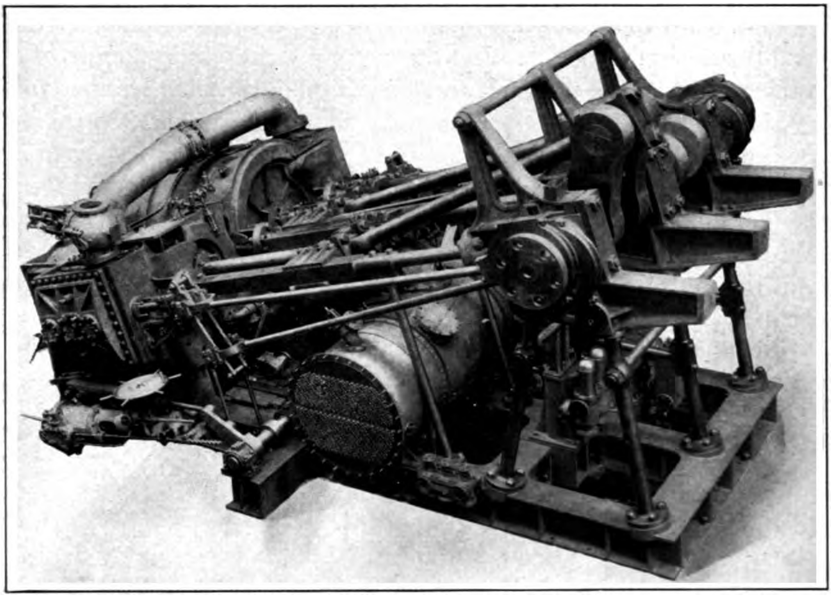


MODERN MARINE ENGINE TYPES.

The upper picture shows the engines of H. M. S. Lancaster, the lower one the engines of the Russian volunteer fleet twin-screw steamer Smolensk; both built by R. & W. Hawthorne, Leslie & Co., St. Peter's Works, Newcastle-on-Tyne.

type in his monumental engine at the Centennial Exhibition in 1876, and as Mr. Porter pointed out at the time, the beam acts as a reciprocating flywheel to absorb the excessive pressure and relieve the crank pin at the beginning of the stroke, and increase it at the last end as the pressure falls off. In ocean and in some river steamers, side beams were used—that is, instead of the beams being placed on gallows frames over the cylinder and crank, two beams were by the side of the cylinder in the bottom of the ship, return connecting rods coming down from a crosshead.

The Watt parallel motion which took the place of crosshead and guide was a brilliant invention. It was ingenious and effective, and enabled the builders of the period to do the work when they had no facilities for making the crossheads and guides cheaply.

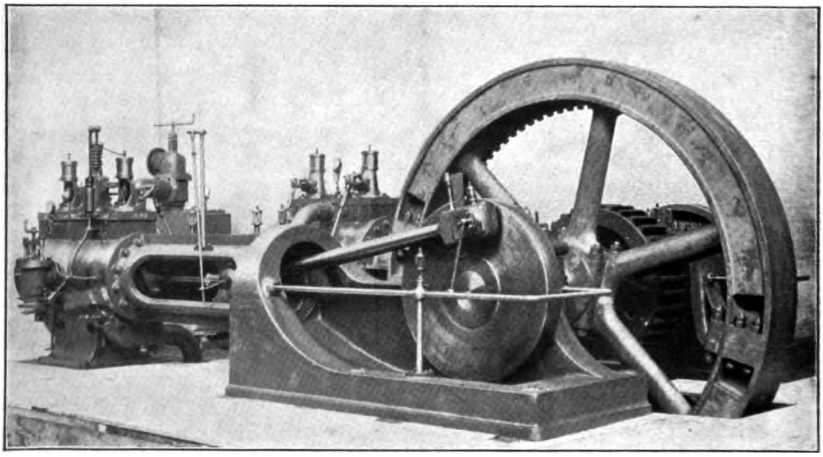


A MARINE TYPE. ENGINES OF THE PADDLE STEAMER DUCHESS OF KENT.
Built by Day, Summers & Co., Ltd., Southampton.

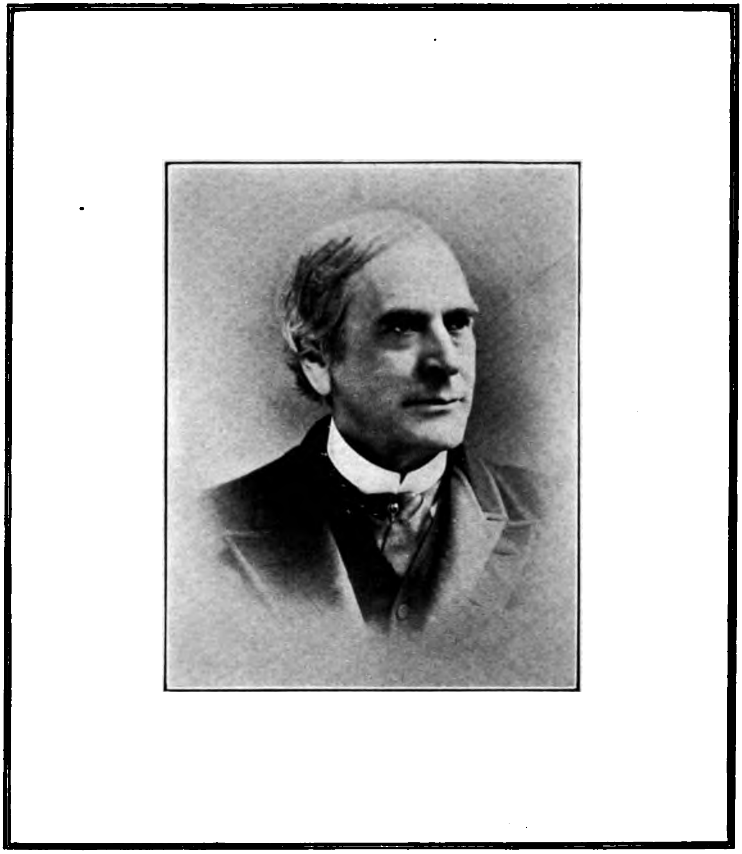
The introduction of steam propulsion into war vessels drove out the beam engine and led to various designs, both successful and the reverse. Horizontal athwart ship engines, with trunk pistons, oscillating cylinders, return connecting rods, and various compact constructions have given way to the direct-connected upright type, with compound, triple, and quadruple cylinders; and in this connection it may be appropriate to refer to the reluctance with which some of the best engineers accepted the fact that there was economy in the compound system.

In the land service engine there has been a much wider range of modifications and freaks than in the marine service, Who was first to depart from the beam engine to the horizontal square-bed engine, it would likely be difficult to find out, but it must have been a standard for many years, both before Mr. Corliss grasped the subject and threw away the useless half, putting the metal in the line of strain, and for many years thereafter. It would be as difficult too to tell when men began to build rotary engines. To say that there have been a thousand different forms of the sort, where the steam is made to push a piston around in a circle and turn the shaft direct would no doubt be far within the limit, and if there has been a uniformity in any one thing it has been the uniform failure of all attempts in this line and the loss of the thousands of dollars has been caused by a misconception of the conditions—first in the idea that there was a great loss in the use of a crank and that the dead centre was a very objectionable feature, and second in the lack of understanding that the losses in the steam engine are heat and friction losses, in which the rotary of that form, even if mechanically good, would kill it. The only rotary engines of any form that have been at all successful have been of the turbine sort, and up to the appearance of the DeLaval and Parsons turbines, the Avery engine, which was also a turbine, had been the only one that ever reached a commercial standing.

About the middle of the nineteenth century, Sickles and Corliss



COUPLED COMPOUND HORIZONTAL FIXED ENGINE.
Robey & Co., Ltd., Lincoln, England.

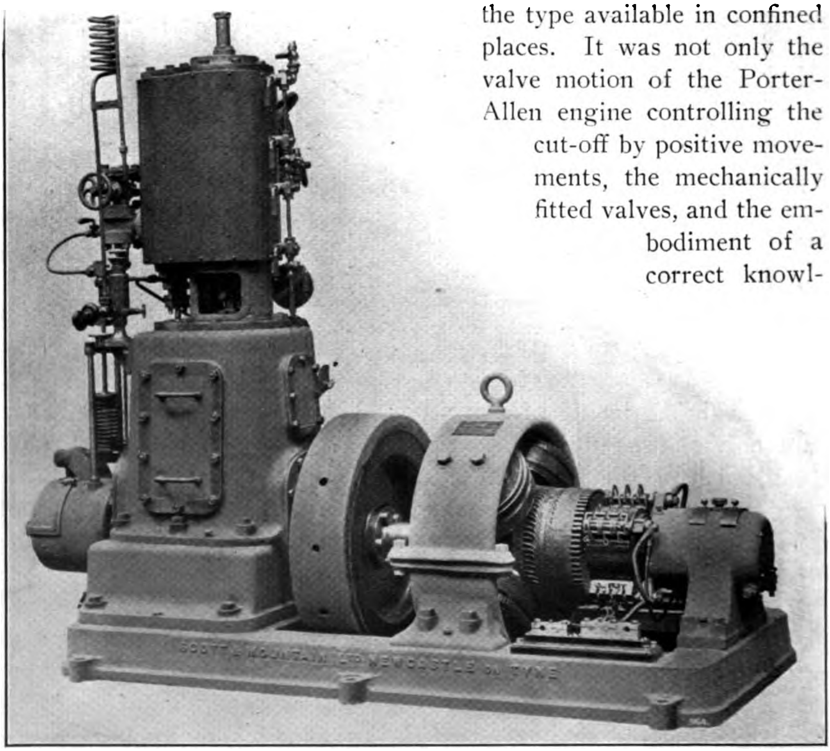


GEORGE H. CORLISS. 1817-1888.

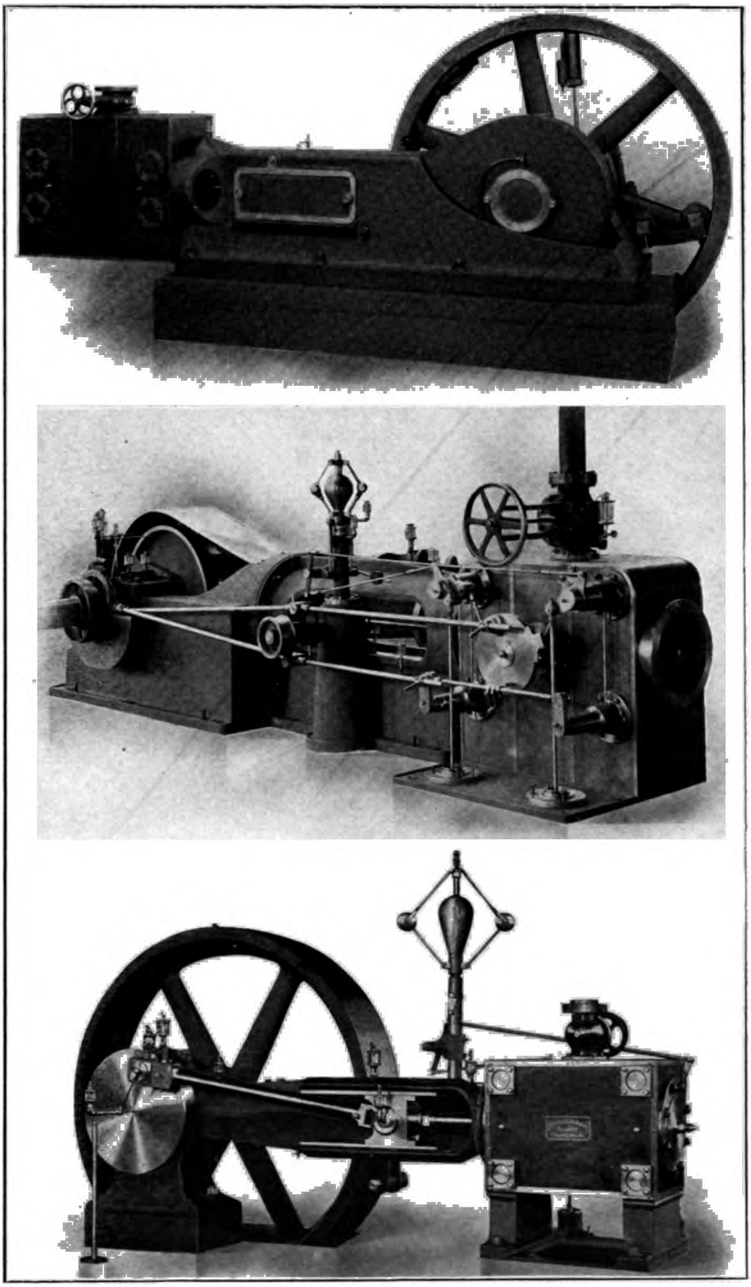
Inventor of the automatic cut-off gear for steam engines, and the practical developer of the four-valve automatic engine.

marked the beginning of a new period in steam-engine work. They not only showed the advantage of a drop cut-off, but Mr. Corliss "builded better than he knew." His governor-controlled cut-off, the four easy moving valves, the liberal exhaust ports which dropped out the steam and the water of condensation as well, really constituted the design of a new engine, and what there was of it was right for the time and conditions; the pedestal under the main bearing was the main support as it needed to be, and it was rigid in the right direction to resist the momentum of the reciprocating parts. The pedestals under the cylinder were located crosswise, permitting expansion of the frame and resisting the side swing of the cylinder whose whole tendency was to swing from side to side. These things were right and the engine so far self-contained. When steam pressures were raised and the frames proved too weak, builders chose to spend their money in other ways than the simple one of making the frame stronger. When we realize that the Corliss engine which in 1867 in Paris met with both approval and ridicule from the engineers, made its way the world over, its marvelous worth becomes apparent.

Allen and Porter designed the true high-speed engine twenty years before extensive use demanded it. It was the beginning of another era in steam-engine construction and the twenty-year period of waiting was not lost, as it proved that the high-speed engine could be made successful and durable. While the electric-light people claim that the electric-light business built up the high-speed engine, it is certain that the electric-light business would never have gone forward with its whirlwind prosperity, if it had not been for the single valve, centre crank, shaft governed high-speed engine. With it good governing under widely varying loads was made possible, and great power in a small space rendered the type available in confined places. It was not only the valve motion of the Porter-Allen engine controlling the cut-off by positive movements, the mechanically fitted valves, and the embodiment of a correct knowl-

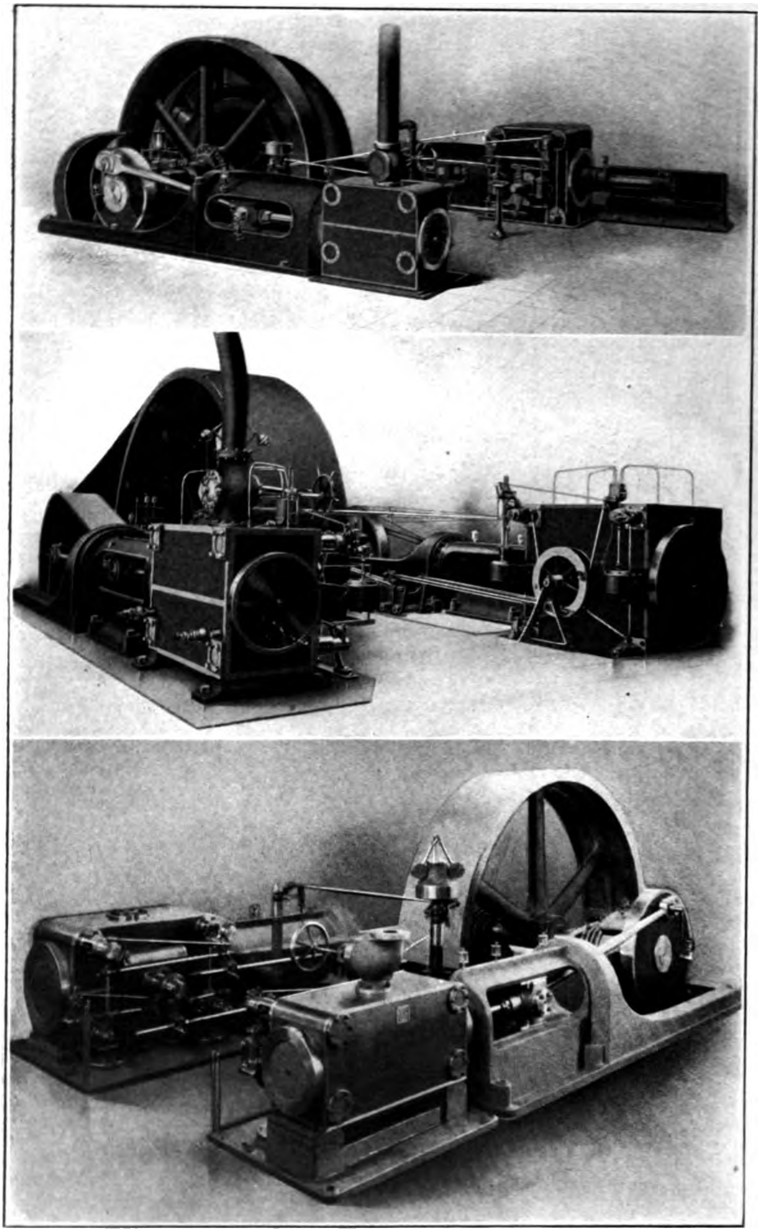


SMALL TANDEM COMBINED ENCLOSED ENGINE AND DYNAMO.



MODERN SIMPLE CORLISS ENGINES AND ALLIED TYPES.

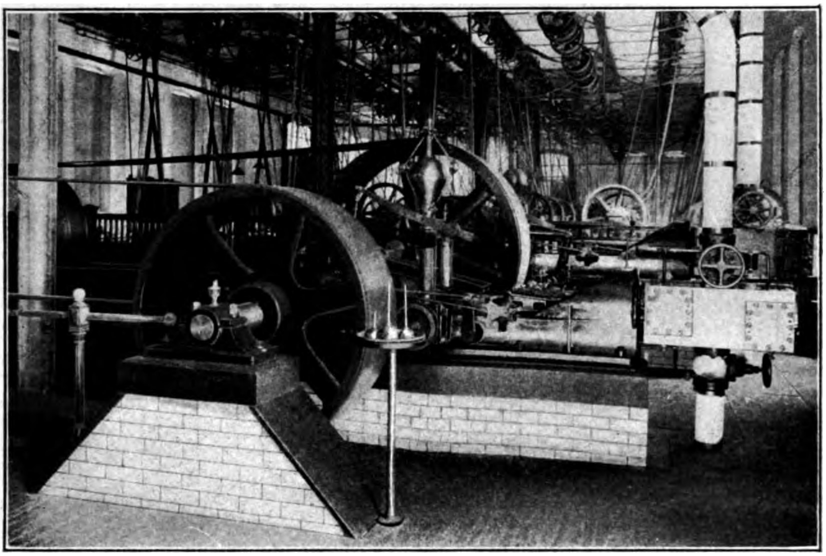
At the top is the 20 by 24 "shaft-governor Corliss" of the Ball Engine Co., Erie, Pa. In the middle is a simple Corliss by the Atlas Engine Works, Indianapolis. At the bottom is a girder-frame Corliss by the Pennsylvania Iron Works.



MODERN TYPES OF COMPOUND CORLISS ENGINES.

At the top is a cross-compound by the William Tod Co., Youngstown, Ohio; the middle one is by the Hooven, Owens, Rentschler Co., Hamilton, Ohio; the lowest is a 350-horse-power engine, 14 and 26 by 42 inches, by the Brown Corliss Engine Co., Corliss, Wis.

edge of the effect of inertia and momentum which made this engine notable. Mr. Porter had designed an engine which was a type that has been extensively followed.



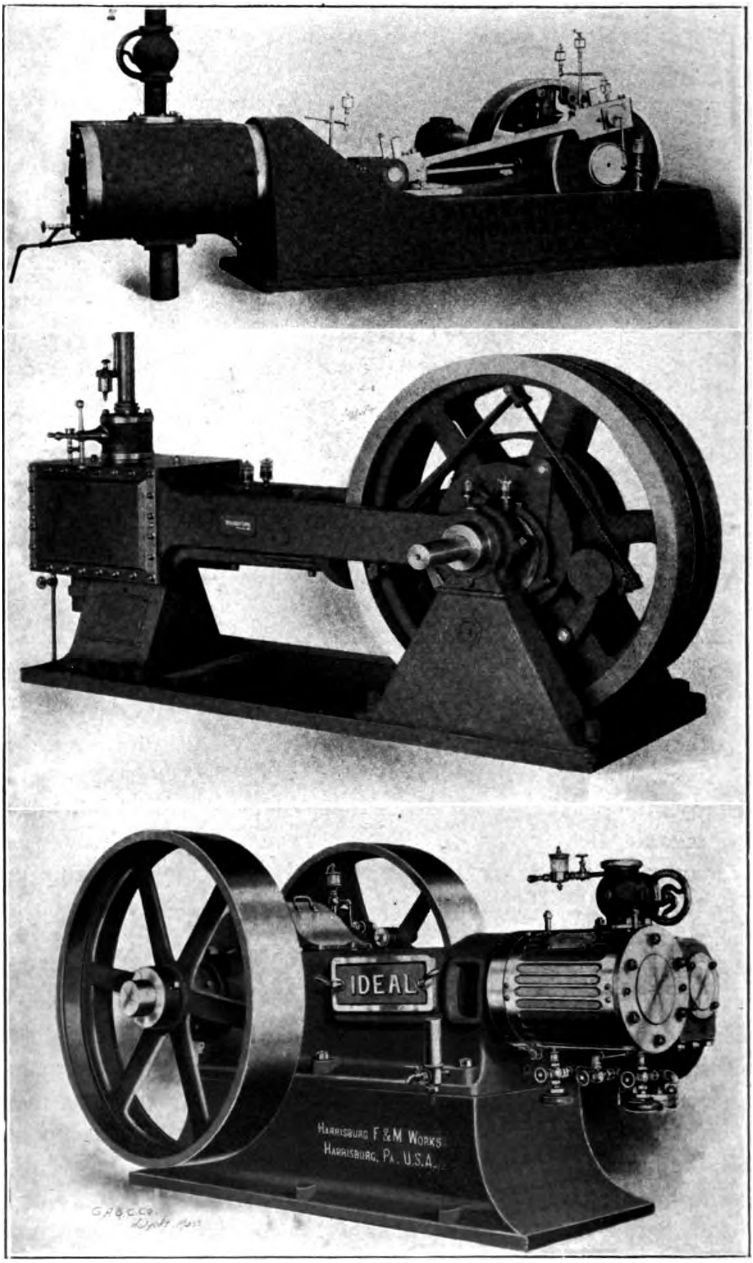
THE MODERN FORM OF THE PORTER-ALLEN ENGINE.

Southwark Foundry & Machine Co., Philadelphia.

Although the gas engine came into notice about the same time the high-speed engine did, and notwithstanding its advantage in fuel economy and in many other ways, it has lagged behind it in coming into general use. The gas engine has grown from the 3 or 4-horse-power ones of the explosive sort, which shot a heavy piston up in the air to turn a shaft as it fell, to monstrous machines working on blast-furnace gas.

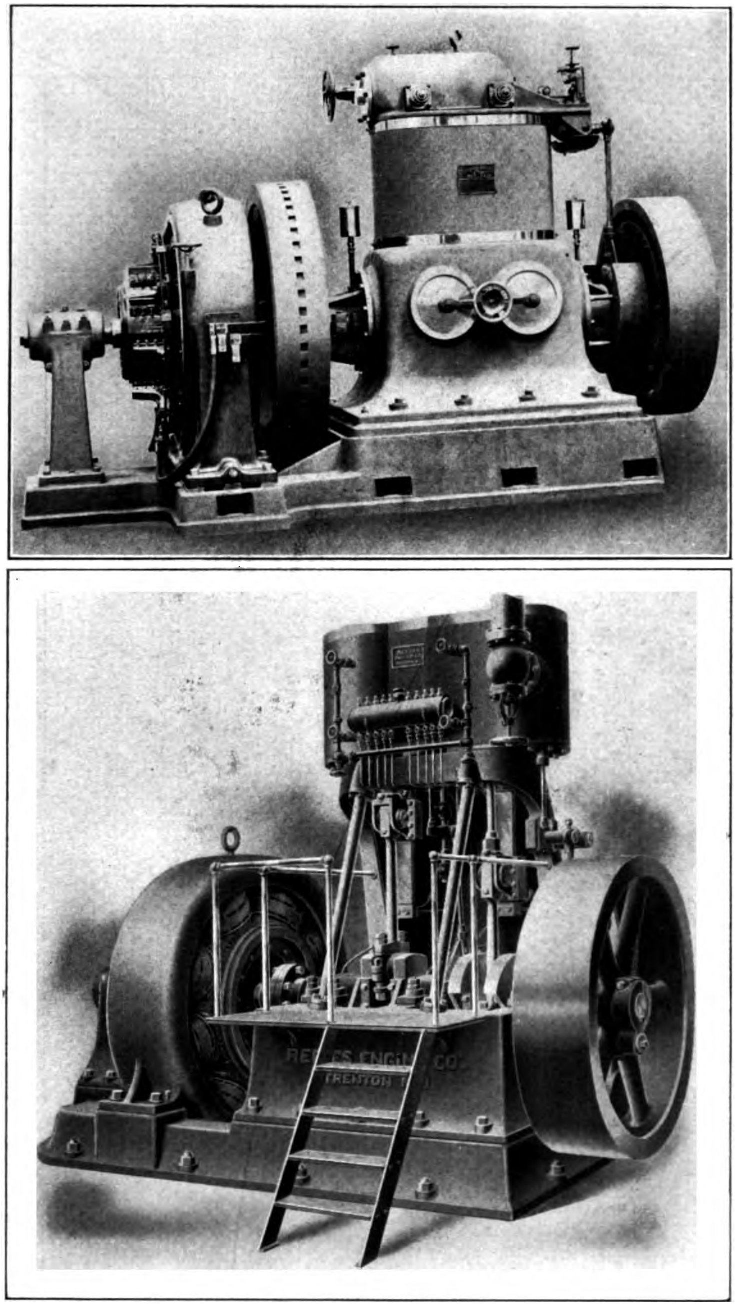
The single-acting enclosed type of the Westinghouse and Willans class followed the high speed in time, and exceeded it in speed; and now the turbine engine of higher speed still, twenty years later, follows these. The vertical marine type, compound and triple-expansion, have come into service for pumping; and in the monstrous modern power stations, and in order to get more cylinders to act upon one shaft, the horizontal and vertical have been combined.

The main strife has been for economy in coal consumption, but the fact that thousands of uneconomical engines have been and are being sold shows that the coal bill has not been all that has been thought of. For electric-light purposes, constant service, good gov-



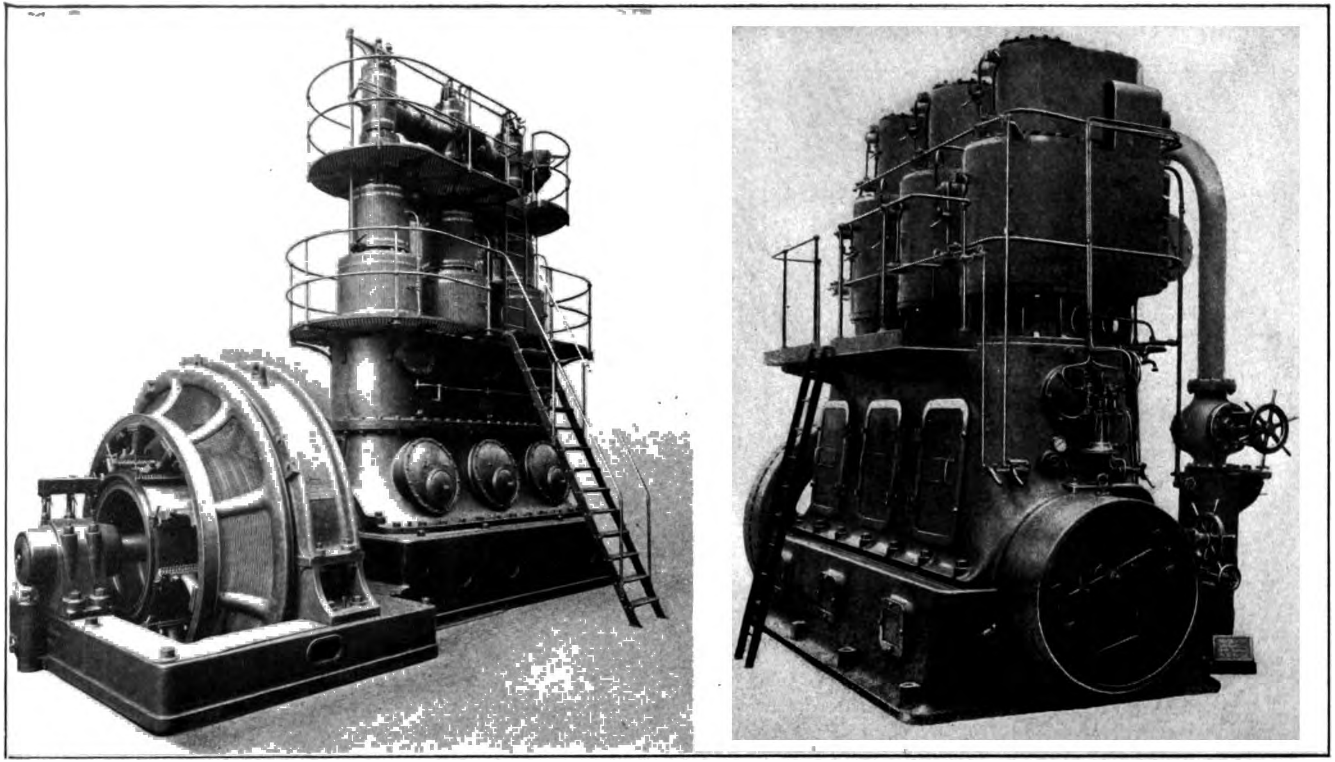
MODERN AMERICAN HIGH-SPEED AUTOMATIC ENGINES.

At the top is the Atlas "standard heavy-duty side-crank." In the middle is the Straight Line engine. At the bottom is the Harrisburg Foundry & Machine Works Ideal.



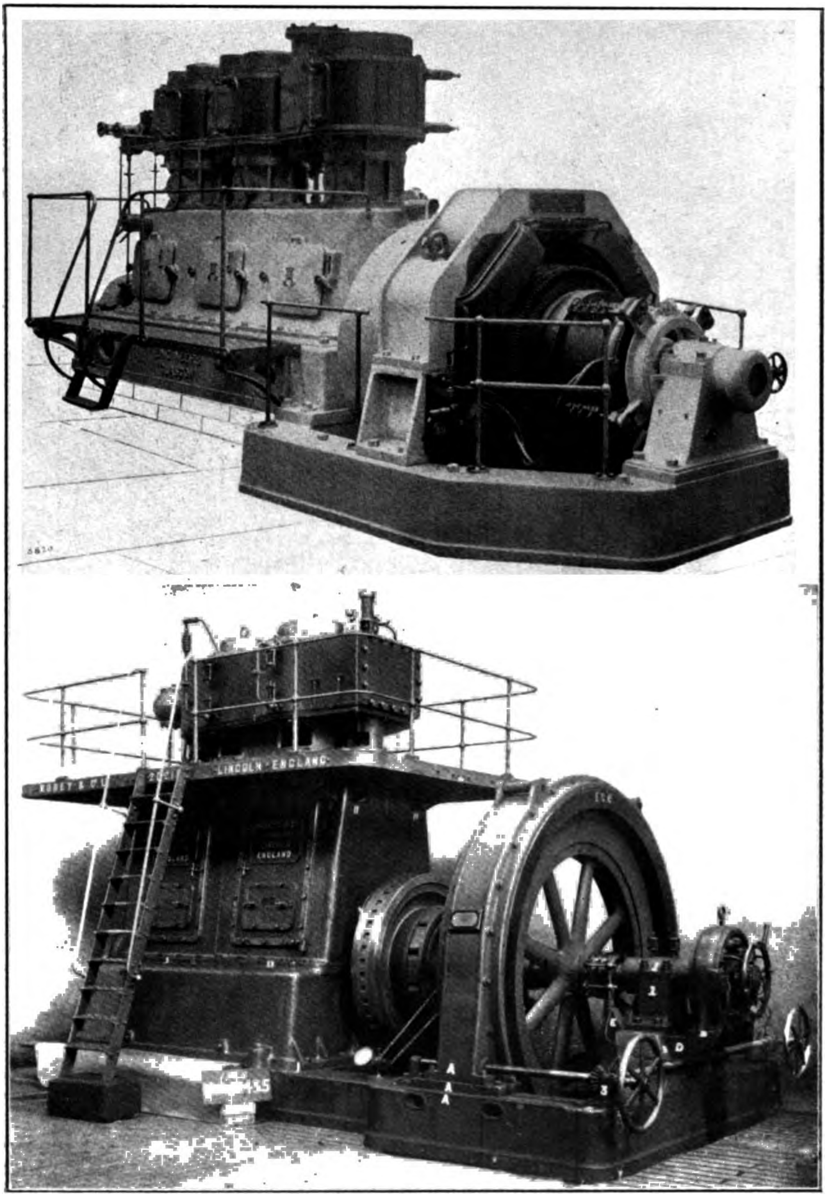
AMERICAN ENCLOSED HIGH-SPEED COMPOUND ENGINES.

Above is a Westinghouse engine of 250 horse power; cylinders 14 and 24 by 14, 280 revolutions; floor space 14½ by 7 feet; height 9½ feet. Below is a Reeves 330-horse-power engine, cylinders 15 and 26 by 18, 200 revolutions. Floor space 100 by 106 inches. It is shown with the casing removed.



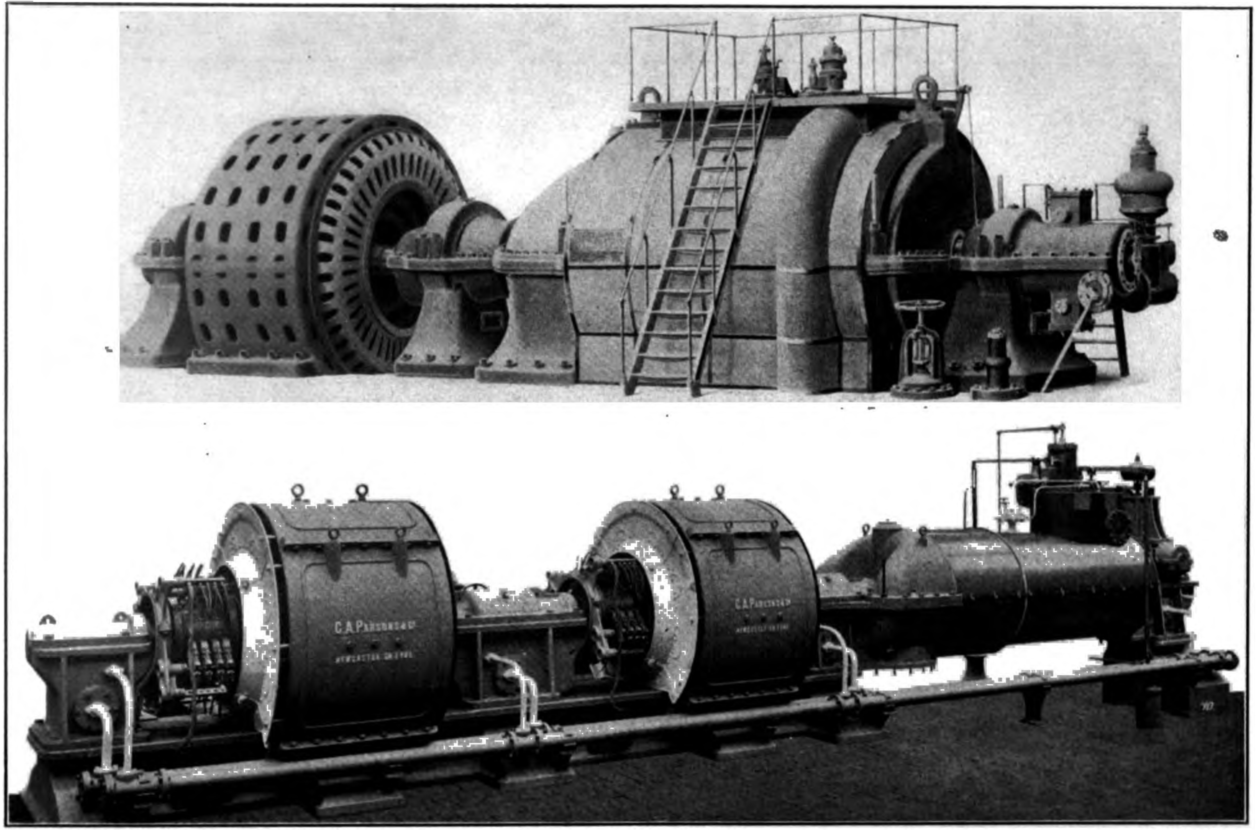
MODERN TYPES OF BRITISH HIGH-SPEED ENCLOSED STEAM ENGINES.

On the left is a Willans nine-cylinder triple-expansion engine—one of the units in Pumpfields Station, Liverpool; cylinders 15, 20½, and 34⅝ inches; stroke 18¾ inches; drives a Siemens dynamo of 1,420 amperes at 550 volts. On the right is a Browett & Lindley high-speed 1,500-horse-power engine for the Liverpool Overhead Railway.



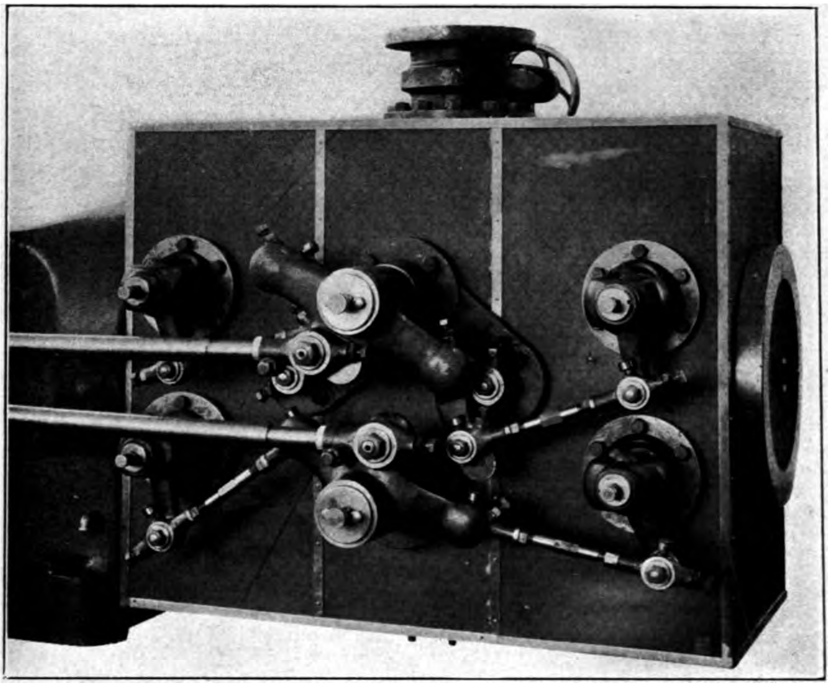
BRITISH HIGH-SPEED ENCLOSED ENGINES.

The upper figure is a three-crank triple expansion 400-horse-power engine, 360 revolutions, by Alley & MacLellan, Ltd., Glasgow. The lower is a compound for electric lighting, by Robey & Co., Ltd., Lincoln.



THE LOWER FIGURE SHOWS THE PARSONS STEAM TURBINE—THE UPPER ONE THE WESTINGHOUSE-PARSONS TYPE.

The Westinghouse-Parsons turbine shown is a 7,300-horse-power (5,500-kilowatt) machine for the P., N. Y. & L. I. R. R.—750 revolutions, 175-pounds pressure. It is 47 feet long, 14¾ wide, 14 high. The Parsons turbo-dynamo is of 1,000-kilowatts capacity, built by C. A. Parsons & Co. for the Newcastle and District Electric Lighting Co., Ltd. It is of condensing type, and takes steam at 180-pounds pressure.



THE ARMSTRONG-CORLISS VALVE GEAR.

Operated by a shaft governor, giving a positive motion to the valves practically identical with that given by the Corliss detaching valve gear. Ball Engine Co., Erie, Pa.

erning, quiet running in isolated plants where exhaust steam is used for heating—all are of more importance than steam economy.

In mills and large power stations any amount of expense seems to be justified if the coal consumption can be reduced, and to accomplish this, higher steam pressure, superheating, more correctly operated valves, reduced clearance, multiple cylinders, the condenser, better workmanship and more perfect lubrication, have all contributed to reach results. At present the trend of improvements is in the direction of direct-connected Corliss valves (that duplicate the effect of the drop cut-off without the detaching element, so as to permit of higher speed); the greater use of the gas engine suited to natural, producer, and blast-furnace gases; and the turbine engine of the DeLaval, Parsons, or Curtis class.

Who could form an estimate of the amount of work that has been expended to bring about present results, and who can comprehend the wasted genius, blasted hopes, and money lost by failures?

WHAT THE INVENTOR HAS DONE FOR THE RAILWAY WORKER.

By Arthur M. Waitt.

There are few manifestations of the use of mechanical power more impressive than the railway, and perhaps none that have had a greater direct influence on industrial civilization and the conditions of life. It is a type and an epitome of the effect of labor-saving machinery. And like the authors whose articles have preceded, Mr. Waitt has taken an intimate part in the development of which he writes. His life has found active expression in the upbuilding of the motive power of a great railway. His review has therefore the vitality of a personal record.—THE EDITORS.

In the popular mind in the year 1904, the inventor is most frequently thought of as one who is devising "new and useful improvements," simply with the object of obtaining a patent which may land him on the road to fame and fortune. In the railroad field, at least, it is a fact that but few of the inventors have been so fortunate as to become either rich or famous through their inventions, and most of the many improvements have come into use free from any patent-office entanglements. A few notable exceptions, however, exist, and two or three of the most helpful inventions for the improvement of the railroad service have brought not only reputation, but fortune to their originators.

Unfortunately there exists too large a class of individuals who have to live by their wits (not their wisdom)—who spend much of their time in devising new and wonderfully made contrivances, about which they know little, either in theory or in practice—and these unfortunate men, who are a prey to unprincipled patent lawyers, are the ones who by the superficial mind are first thought of as representatives of the *genus homo* known as inventors.

Popularly speaking, the hope of getting a money-making patent is the incentive to invention. Actually, "*necessity* is the mother of invention," and it is such necessities that have given us the sewing machine, the printing press, the Pullman car, and the modern locomotive.

Perhaps no better idea of the work, both mercenary and philanthropic, done by the inventor for railroad men, can be obtained than by a view of the railroads and the railroad equipment as they existed in their infancy nearly seventy-five years ago, and by following their progress, through the indefatigable work of the inventor, up to the modern development in the wonderful service and equipment of the railways of today.

The then marvelous railway of the early nineteenth century was equipped with a track composed of strap or thin bar iron, about one and three-quarters inches wide, rolled in lengths of 15 feet and weighing about 20 pounds to the yard, supported on longitudinal stringers. The Stephenson locomotive, the "Rocket," weighed 4½ tons. The boiler contained twenty-five 3-inch copper tubes, and was 6 feet long and 40 inches in diameter. The cylinders were inclined and coupled to a single pair of driving wheels. This engine could draw a single carriage at 25 to 30 miles per hour. The carriages were simply duplicates of an old stage-coach body set up on a simple framework which was carried by two pairs of wheels. The signal code was very primitive. When a train was to be stopped at a station or a house at night, a common candle was lighted and placed in the window. On the road, when it was desired to stop a train, a piece of tow line was ignited by a shovelful of red-hot coals. Brakes of the ordinary kind used on stage coaches were all that were provided.

From this crude beginning, the inventor, often with little or no recompense except his own consciousness of the benefits he was conferring, has developed our modern railroad, the marvel of the past century. It might be interesting to trace the work of the inventor in developing the modern track with its cross ties of wood or pressed steel, its heavy T rail weighing 100 pounds to the yard, the money-saving tie plates, the splice bars, the safety switches, and the elastic frogs; it might also be profitable to trace the growth of the locomotive from the diminutive "Rocket" to the modern Atlantic or Pacific types of passenger engines, or the consolidation or decapod freight locomotives; and also to trace the car from the old stage-coach type to the modern coach, or the Pullman sleeper and the dining car with their many home comforts. Much of this interesting development of the inventor would not however pertain to the especial benefit of the railroad worker.

Most prominent among the inventions especially helpful to the railway man, as well as to the general public, are the automatic coupler, the automatic quick-action air brake, the steam heating of cars, the application of gas or electricity for car lighting, the pneumatic and other styles of interlocking switches, the block signal systems, the use of telegraphic train orders, and the modern methods of handling coal.

In the workshops of the railroad, the workers have been benefited by the many great improvements which have especially made the life and condition of the American mechanic far superior to his European brothers in labor. Hydraulic and electric cranes for handling heavy work, electric lighting for shops, improved systems of shop heating and ventilation, pneumatic tools as a substitute for the slower and more laborious hand tools, have all made it possible for the shop worker to earn more money, enjoy more rest, have better shop and home surroundings, and find more employment than ever before in the history of the world.

It will be of interest to consider more at length the results to the worker of some of the more marked developments of our inventors in the railroad field. Probably no two inventions have done more to benefit the railway men in actual train service than the automatic coupler, and the automatic quick-action air brake.

The automatic coupler is primarily a device to improve the conditions surrounding the life of switchmen and trainmen, first brought out by Ezra Miller of Dunkirk, N. Y., in 1863, in connection with a platform construction for the added safety to passengers. It brought about, by its universal adoption in the United States, the doing away with the necessity for employees going in between the cars in order to couple or to uncouple them. The fact that dangers were still found, even with the Miller coupler, led to an improvement made by Janney some years later, which became the basis of the Master Car Builders' "standard coupler," which is the universally adopted safety coupler in use all over the United States, for both freight and passenger cars and for locomotives. The benefit of this invention is most clearly shown by referring to the remarks of Mr. E. A. Moseley, Secretary of the Interstate Commerce Commission, before the Master Car Builders' Association at their annual convention in June, 1903, from which I quote:—

> "It must be very gratifying to you to know that the report for the year 1902 shows that the annual number of casualties due to coupling and uncoupling has, since the law was enacted in 1893, been diminished more than nine thousand; the number of employees killed, shows a diminution

> of sixty-eight per cent., and the number injured, of eighty-one per cent.; and this notwithstanding the fact that there were from fifteen to twenty thousand more men engaged in coupling cars on the later date."

It is oftentimes the erroneous conclusion in connection with automatic devices, that, as they supersede the necessity for so much manual labor, the result is to throw out of employment many workers. Not so with the automatic coupler. Not only has it saved thousands of lives and limbs, but it has enabled the railroads to handle more business in less time, and for less money, and also to handle heavier trains with safety, thereby taking care of more traffic on a given piece of railway. This has made work for more men in every department. The work of the trainman, and especially that of the switchman, has been rendered less hazardous; trains are made up with greater rapidity; trainmen lose less time on the road from breakage of couplers, and the breaking apart of trains due to such breakage of couplers.

Of equal importance and benefit to the railroad man was the invention of the simple air brake, and afterwards of the quick-action automatic air brake by George Westinghouse. Without doubt this invention has been more far-reaching in its results than any other invention connected with railroad equipment.

The primitive stage-coach brake of 1830 gave way some twenty years later to the Hodge and the Stevens type, operated by a wheel and a shaft located at the end of the cars. Later came the Tanner and the Creamer brakes, each being an improvement over the previous types in safety, ease of application, and effectiveness.

In 1869 George Westinghouse brought out his first successful air brake, with which the engineman could control the train by means of air pressure generated by a pump located on the locomotive, and conducted back through the train, by means of pipes having flexible connections between the cars, to air cylinders located under the bodies of the cars, which are effectively connected with the levers and rods forming the brake system on the cars. The demand for longer trains and heavier cars, together with the call for higher speeds, and perhaps more than all the desire for the use of air brakes on long freight trains, called for further development, and again Westinghouse with his wonderful inventive genius was equal to the demand. His next and greatest production was the quick-action automatic air brake, equally applicable to freight and passenger trains, which permits the control of the train from any car in a passenger train, and which in case of the train breaking in two, will automatically apply the brakes and safely bring both the separated parts of the train to a stop, and at the same time will give the engineman warning of the separation of the train. The invention and adoption of this type of automatic brake has made a complete change in the demands upon, and the conditions surrounding, trainmen. Before its advent it was necessary for the trainmen to apply the brakes by hand, and therefore to be near or on the platform of the cars on passenger trains, and on freight trains to ride mostly on the roofs of the cars in all kinds of weather. This is now all changed, and not only is great risk to life and limb of trainmen avoided, but they are able, in severe and stormy weather, to be much of the time comfortably located in the caboose or the locomotive cab at their respective ends of freight trains, or attending more to the comfort of passengers on passenger trains. With the use and development of this invention has come, not only greatly added safety to trainmen, as well as to passengers, but the possibility, with perfect safety, of much faster speed and longer trains. This means shorter hours for the men, and also the possibility of handling more trains and cars, which with the natural development of business has given employment to many more trainmen, as well as more men in every other department of the railroad service and in the industries dependent upon it.

In the improved methods of heating cars, the railroad worker has largely benefited by what the inventor has done. In earlier times no heat at all was provided; then a step in advance was taken by furnishing small individual heaters, or foot warmers; next an advance was made to wood-burning stoves, followed by coal burners. These required constant attention, and made dirty and disagreeable work for the trainmen in providing the supply of fuel, and looking out for the accumulation of ashes. Now, thanks to the inventor, the trainman has a clean and dignified class of work, and together with the passengers can have the comfort of warm cars, heated by steam furnished from the locomotive. The terrible accidents which often occurred from fires in stoves which had been overturned by collisions have been done away with, and both railroad men and passengers can travel without apprehension in that regard.

Great beneficial results to the railroad worker have come through the invention of the improved pneumatic, or electrically operated switches. In large terminal switching yards, which are a perfect network of tracks, the life of the switchman was formerly one of great danger and exposure in severe weather; now, thanks to the inventor's skill, switches and signals at far distant points are safely and surely operated from a central station by skilled men comfortably housed and protected. By means of the interlocking features, the operators are safeguarded against the possibility of a mistaken throwing of a switch which might cause a collision and possible loss to life and property.

The dirty and most disagreeable operation of coal handling, which plays such an important part in the work on the railroad, has through the work of the inventor been relieved of many of the unpleasant features. Where formerly the work called for large numbers of the lowest grade of labor, and the work was of the slowest and dirtiest character, now it is conducted with speed, economy, and comparative cleanliness, and the labor is performed with a higher grade of workmen and their duties are of a much more desirable character.

These, and many other of the mechanical and automatic devices brought out by the inventor in connection with railroad service, have rendered employees' lives safer, their occupations more dignified, their wages higher, their possibilities for earning greater, and the inducements to improve the mind by becoming skilled artisans rather than mere manual laborers have been much increased.

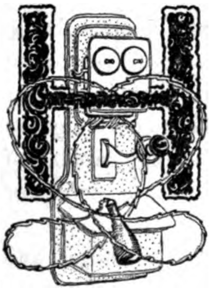
The inventors' success in raising the standard of accomplishments possible for men in the shops, in the freight houses, and in the offices even, by means of labor-saving machinery and automatic devices, is too well recognized and the improvements are too numerous to permit of individual mention in this paper. One of the greatest beneficial results of all that has followed the work of the inventor is the incentive given to the worker to improve his mind and skill, and so to become capable of taking a higher rank as a man and as a producer than was possible for the men of fifty years ago.

With the inventions has come less need for the mere drudge, and a greater call for a higher grade of workers, and this without reducing the number of men needed. For every new improvement seems to open up new fields for work, and new demands for employing men to meet the gradual but sure uplift in the general condition of the worker, both in the railroad service and in the general field of industry.

HYDRAULIC POWER APPLIANCES IN ENGINEERING INDUSTRIES.

By George H. Baxter.

Hydraulic generation of power, after a period of subordination to the steam engine and consequent decline, is coming again to the fore through the mobility given by electric transmission. The purpose of this number, however, is to display applications of power rather than generation of power, and it is to this aspect of hydraulics that Mr. Baxter addresses himself. Here he takes as his first theme the larger uses which have found their highest development in the machinery provided at the leading English ports. Even in this field the examples are so many that we have had to reserve for a following article the discussion of cranes and capstans, and to a later occasion still the miscellaneous uses of hydraulic tools and appliances in shops and works; confining the present review to the general elements of the question and the applications to coaling machinery.—The Editors.



HYDRAULIC machinery may be divided into three classes, the first embracing all machines used for the production and transmission of power, the second those for transmission only, and the third—which may be generally described as "appliances"—those for the utilisation of hydraulic power. This last forms by far the largest class.

Before describing some of these machines and appliances in detail, it may be interesting to recall the most salient of the outstanding features in the history and development of hydraulic power.

In the latter half of the eighteenth century, before the advent of the steam engine, the chief source of power and means of transport was water. Industries were developed in towns adjacent to streams where sufficient fall was available for driving water wheels, and latterly turbines, for transmitting power to mills and factories, pumping water from mines, and for other purposes. These belong to the second class of appliances.

Water wheels are of three kinds, "overshot," generally used with falls of from 10 to 70 feet, "breast" wheels, with lower falls, and "undershot," wheels, where the falls range from 5 to 8 feet. In the two former, the power acting on the wheels depends on the volume of water and the height through which it falls, the efficiency varying from 60 to 75 per cent. In the last, the power is dependent on the momentum of the water at the bottom of the wheel, the efficiency in this case ranging from 60 to 70 per cent. All wheels were at first constructed of timber, but the two first-named were greatly improved by Fairbairn, who introduced an improved form of bucket made of sheet iron, a system of ventilating the buckets, a modification of the breast to economise water, and the method of transmitting the power by fixing the large spur wheel to the arms instead of at the end of the axle, which, while strengthening the arms, allowed of a larger spur wheel being adopted and of driving the pinion on the main shaft direct without intermediate gearing. The old type of "undershot" wheel was much improved by General Poncelet, who, by fixing the best proportions of the diameter of the wheel to the height of the fall and improving the form of buckets, greatly increased the efficiency.

In later years turbines have been extensively used. In America, at Niagara Falls, in Switzerland, and in other mountainous countries, where an abundant supply of water having a comparatively high fall can be obtained, these machines have been adopted to work electric-generating plant for distributing power over very large areas at a very low cost. But these natural advantages can be profitably utilised only when the fall is within a reasonable distance of the places where power is to be distributed. In Great Britain, however, and in other countries where the natural supply of water is intermittent, and in dry seasons frequently ceases altogether, water power has been supplemented and, in many cases, entirely superseded, by steam power, and the old water wheel is therefore now regarded more as a relic of a past age than as an agent for transmitting power.

While the steam engine thus gradually displaced the water wheel, it also gave rise to a new system of producing and transmitting hydraulic power second in importance only to that of steam power itself. The hydraulic press, the principle of which was originally enunciated by Pascal about the middle of the seventeenth century, was first brought into practicable shape by Bramah about the year 1796, when he introduced an improved method of packing the hydraulic ram by means of cup leathers, which are used in much the same form at the present day. This invention greatly stimulated the development of hydraulic appliances, as it enabled much higher pressures to be used and largely increased the efficiency of the press.

From the original hand-wrought pump it was an easy transition to the application of steam pumping engines for working the hydraulic press, the principle of which was applied in the design of many different kinds of tools and other appliances. Bramah first used steam pumping engines to produce and transmit hydraulic power for working cranes and other machines, and in a letter to Robert Mallet* in 1802, which, for want of space cannot be quoted at length, he concludes a very enthusiastic statement of the capabilities of this new power thus:—"I believe I shall have all the cranage of the London wet docks and warehouses to undertake, which will be the grandest job perhaps ever done." This prophetic letter seems to fortell the advent of the present system of transmitting hydraulic power from a central station to work cranes and other machinery, but as yet this could be done only in a "kind of way": there was no satisfactory method of regulating the pressure or the supply. In 1840† Armstrong proposed to pump water by a small steam engine, working continuously, into an elevated reservoir from whence a sufficient supply at constant high pressure could be obtained for machines working intermittently. Other devices were tried, such as air chambers and high towers, to give the pressure required, but these also proved unsatisfactory. Shortly afterward the development of hydraulic power received an enormous impetus by the inventive genius of Lord Armstrong, who devised the loaded accumulator, and also originated and brought to a very high state of perfection the modern system of hydraulic power transmission from a central pumping station through miles of piping to work hydraulic appliances of all kinds. Every seaport of any consequence throughout the world now has its docks equipped with at least one hydraulic power installation for working cranes, capstans, jiggers, coal-hoisting appliances, grain elevators, dock gates, sluices, swing bridges, and hauling machinery; every large railway goods yard, iron and steel works, forge, foundry, shipbuilding yard, engineering and boiler works, bridge-building and other constructive establishment, oil factory, tube-making works, etc., is provided with hydraulic appliances supplied with power from their own or from some co-operative or municipal installation. Hydraulic power stations for public supply have now been installed in several large towns for distributing power to work elevators, presses, and motors of many kinds in smaller industries. ‡The first of these to be established was at Hull, in 1877, then followed London in 1884, Liverpool in 1888, Melbourne in

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* Professor Robinson, C. E., "Hydraulic Power and Hydraulic Machinery," p. 192.

† R. G. Blaine, M. E., "Hydraulic Machinery," p. 170.

‡ Paper by E. B. Ellington, M. E., on "Hydraulic Supply in Towns," Proceedings Institute M. E. See also Mr. Ellington's articles in THE ENGINEERING MAGAZINE, May and June, 1899.

1889, Birmingham in 1891, Sydney in 1891, Antwerp in 1894, Manchester in 1894, and Glasgow in 1895. The working pressures range from 700 to 800 pounds in all except the two last-named cities, where they are 1,120 pounds per square inch. London has by far the largest system in the world. The London Hydraulic Power Co. has several stations each of about 1,200 horse power, and in 1895 had 85 miles of mains laid in the streets. War vessels, merchant steamships, dredges, barges, crane punts, and other craft are in a great many cases provided with hydraulic plant to supply power for working turrets, guns, presses, lifts, cranes, capstans, winches, windlasses, steering gear, grabs, etc., the water pressure being regulated by means of an accumulator loaded by steam pressure.

Special applications of hydraulic power on a large scale may be mentioned, but the space at our disposal will not admit of going into details. In some canals, such as that at Anderton,* barges, with the trough in which they are floated, weighing altogether 240 tons, are raised to a height of 50 feet, to connect the river Weaver with the Trent and Mersey Canal. This invention, designed by Sir Leader Williams to dispense with a large number of locks, effected a very great saving of canal water, using only 1.7 per cent. of the quantity required if locks had been employed. Similar lifts designed by the late Sir Edwin Clark have since been constructed for canals in France at Les Fontinelles near St. Omer, and in Belgium at La Louvière on the Canal du Centre, near Mons, where the load on each ram is about 1,120 tons, the height through which the trough containing the canal boat is raised being 50 feet. Floating graving docks, notably at Bombay, London, Malta, and elsewhere, worked by hydraulic machinery, have been constructed by which vessels up to 6,500 tons and drawing 30 feet can be lifted clear out of the water for examination and repairs. Slip docks, where large vessels are drawn up on a carriage for a similar purpose, are provided at many ports in Great Britain. Swing bridges over rivers and dock entrances, like those at the Tyne and the Clyde, and bridges of the bascule type, notably the Tower Bridge over the Thames, are operated by hydraulic power.

In the construction of the Forth Bridge many special hydraulic appliances had to be designed for bending, planing, drilling, and rivetting the steel plates before and after erection. Some of the rivetting machines used in contracted spaces were so small that a pressure of 3 tons per square inch had to be employed to close the river. †In

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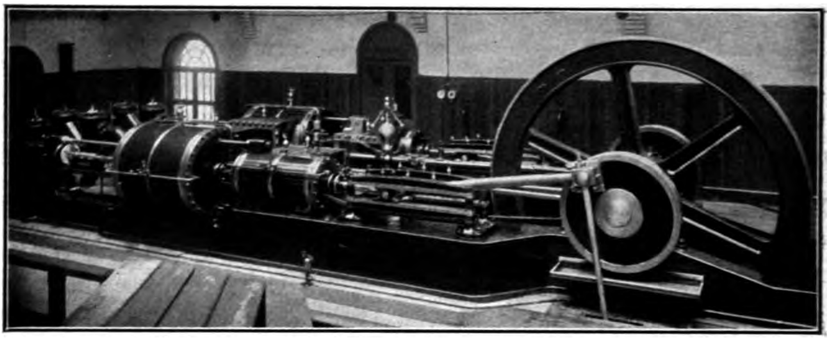
* Professor Robinson on "Hydraulic Power and Hydraulic Machinery," p. 44.

† Professor Robinson on "Hydraulic Power and Hydraulic Machinery," p. 125.



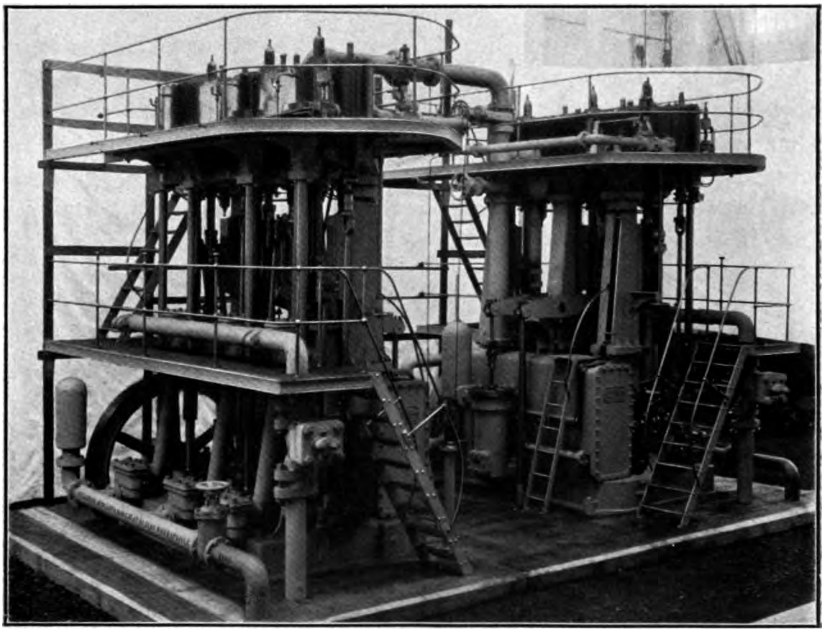
FOUR-CYLINDER TANDEM-COMPOUND HORIZONTAL PUMPING ENGINES FOR HYDRAULIC POWER INSTALLATION.

Sir W. G. Armstrong, Whitworth & Co., Elswick Works.

the great 1,700-feet spans the massive girders were built at a low level and raised as high as the top of St. Paul's Cathedral by hydraulic power. The continuous girders, nearly one-third of a mile long, used in the construction of the high pillars, carrying sheds, cranes, appliances, and workmen, the whole weighing in some instances more than 1,000 tons, were similarly raised. Hydraulic spades were used in excavating the foundations for the piers, in an electrically lighted diving bell 70 feet in diameter, and 90 feet below the sea. The history of the construction and erection of the Forth bridge, from start to finish, would form one of the most interesting and instructive accounts of the use of the most ingenious and varied descriptions of hydraulic power appliances, and we may give descriptions of some of these in a future article.

Hydraulic power is so largely used for dock machinery that a description of the various appliances for its production and utilisation would be sufficient to fill a fairly large book, but I shall endeavour to give, as briefly as possible, a few of the leading particulars of some of the appliances used in a typical modern dock equipment, such as that at Princes Dock in Glasgow harbour, where the greater part of the quayage is used for general cargo and the remainder for minerals.

Where room is available, the compound horizontal two-cylinder, or the four-cylinder tandem type of pumping engine with surface condensation, as shown in the photograph above, is most usually selected. The pumps in these engines are in line with and connected to the tail ends of the piston rods, and have buckets working in brass-lined barrels, the pump rod being half the area of the bucket. In this class of pump there is during each revolution a single suction at each outward stroke, filling the barrel, but a discharge at each end equivalent to half its capacity, thus giving a practically continuous flow. But where space is limited and floor space is costly, the three-cylinder vertical triple-expansion surface-condensing engine of the marine type is frequently adopted. The illustration represents two sets of three such engines installed at Princes dock. The cylinders are 15, 22, and 36 inches diameter, the stroke 24 inches; each drives direct from the piston rod crosshead a single-acting hydraulic ram 5 inches in diameter working in a cast-steel gun-metal-lined pump chamber, and each set of engines can deliver 300 gallons per minute at a pressure of 750 pounds per square inch when working at 60 revolutions per minute. Steam is supplied at a working pressure of 150 pounds per square inch, by two multitubular boilers of the two-furnace marine type, each being 11 feet diameter by 10 feet long, the total heating surface of both boilers being 2,000 square feet. Two similar boilers, one of them being a spare boiler, have recently been added for the electric-lighting plant, and are so connected by steam piping as to be also available for working the hydraulic pumping engines. One boiler is generally off for cleaning while steam is on the other three.



VERTICAL TRIPLE-EXPANSION PUMPING ENGINE FOR HYDRAULIC POWER INSTALLATION.

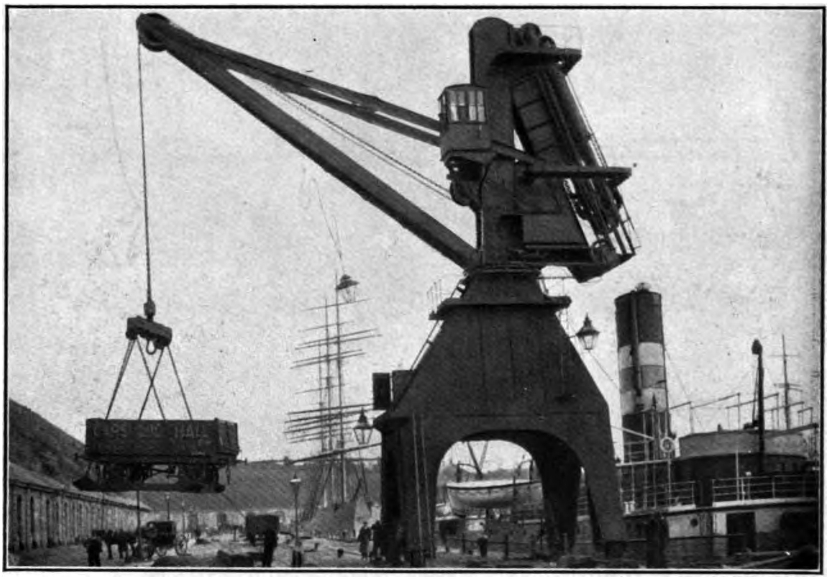
Fullerton, Hodgart & Barclay, Ltd., Vulcan Works, Paisley.

Two accumulators are provided for the installation and placed side by side in a large tower adjoining the boiler room. Each is 20 inches diameter by 20 feet stroke, and the casings are loaded with sand to give a pressure of 750 pounds per square inch on the ram, which with its load weighs about 110 tons. One of these is the working accumulator, which is loaded slightly heavier than the other and has an automatic connection with the main throttle valve for cutting off the supply of steam when the ram is full-out. In normal conditions the lighter loaded accumulator is usually at the top of its stroke, full-out, and, to prevent its being forced too hard against the stopper beam by the heavier loaded accumulator while being pumped up, a shallow steel tub loaded with old iron is suspended by chains fixed to the beam, so that when the light accumulator gets near the top of its stroke the additional weight of the steel tub is taken up by the ram, thus increasing the load upon it and bringing it to rest before touching the beam. As an additional precaution, a loaded safety valve, worked automatically, is provided at the inlet to the accumulator cylinder.

The main pressure pipes, 7 inches diameter, are led from the accumulators to the southeast corner of the dock, and thence in a tunnel along the south quay, where the mineral traffic is worked, and at the west end are reduced to 5 inches diameter; from there they are led all round the graving docks, to provide water for working hauling engines for the dock caissons, division-gate rams, capstans, and sluices for the dock-pumping machinery. Branch pipes 4 inches diameter are led along each of the other quays in tunnels to provide a supply for the cranes. All the water pumped, except that used for the graving docks. is returned through pipes laid alongside the pressure mains, ranging from 8 inches down to 5 inches diameter. Hydrant boxes, spaced about 33 feet apart, having valves and branch pipes joining the mains, are provided along all the quays, the pressure connections to cranes being made either by wrought-iron walking pipes or flexible hydraulic armoured hose. Branches are also led to about 60 capstans distributed over the quays for hauling wagons and for shifting cranes when required. All the tunnels, cranes, and capstans are heated by gas when necessary during winter to prevent damage by frost, and for the same reason great precautions have to be taken to keep all exposed pipes and cylinders drained when not in use. Stop, momentum, air, and drain valves are also fitted to the main pressure pipes, which are arranged on the "ring" system where possible, so that the supply to any set of appliances may be maintained when one portion of the piping may have to be temporarily shut off for repairs.

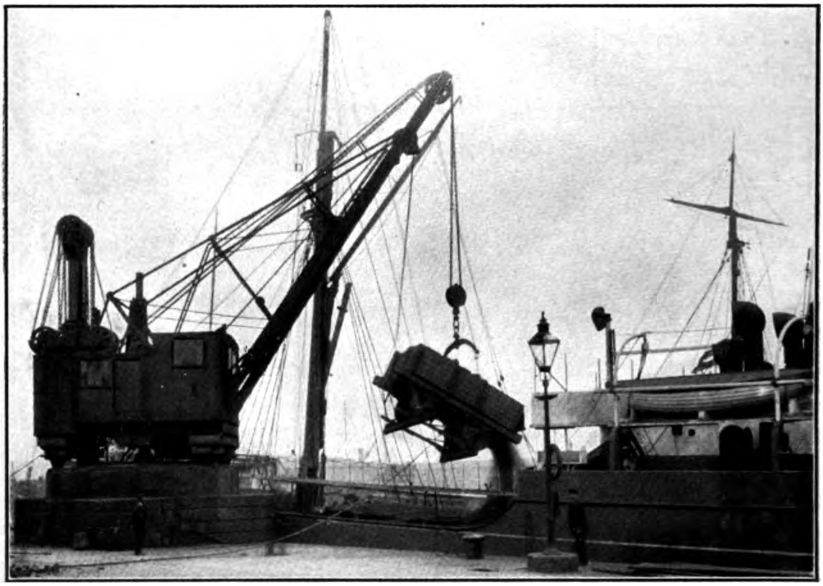
Coal Shipping Appliances, Cranes and Hoists.—On the Tyne, and at most of the northeast coast ports, coal is shipped by gravitation from hopper-bottomed wagons, which are run onto high staiths and emptied into shoots which conduct the coal to the hatches of the vessel. This is a cheap and expeditious process, but one which tends to break the coal whereby it is much deteriorated in value. At other parts, especially those in South Wales, the wagons have end doors, and are handled by cranes or hoists nearly all worked by hydraulic power.

When cranes are used, the wagon is run onto a cradle, lifted, and shoved over the hatch and then tipped, the coal being emptied directly into the hold. With hoists, the wagon is also run onto a cradle, lifted and tipped, the coal running down a shoot leading to the mouth of the hatch.



MODERN MOVABLE HYDRAULIC COAL-SHIPPING CRANE, LIVERPOOL HARBOUR.

The photograph illustrates one of two modern cranes erected at Liverpool by Sir W. G. Armstrong, Whitworth & Co., Ltd., and shows the process of shipping coal. The cranes are movable, can be placed to suit the hatches of the vessel being loaded, and are adapted to ship coals from trucks either of the end-tip or hopper type. The hoisting cylinder with its ram and pulleys is arranged inside the mast and pedestal, while the turning cylinders are placed at the back of the mast near the top, the tipping cylinder being arranged between them. With the cradle shown, constructed by the same firm, turntables are unnecessary and the empty wagons are easily got rid of. In this appliance the crosshead carries a circular box provided with conical roller bearings on which the whole load turns. A sleeve connected to the middle of the cradle beam has a nut and washers in the upper end bearing on the rollers. The tipping chain has a bridle chain, attached to the lower end, which passes through the sleeve, thence to each end of the beam and, each part passing down over pulleys, is connected to the back end of the cradle at each side. The cradle seat is seen on the rails running underneath the pedestal of the crane.



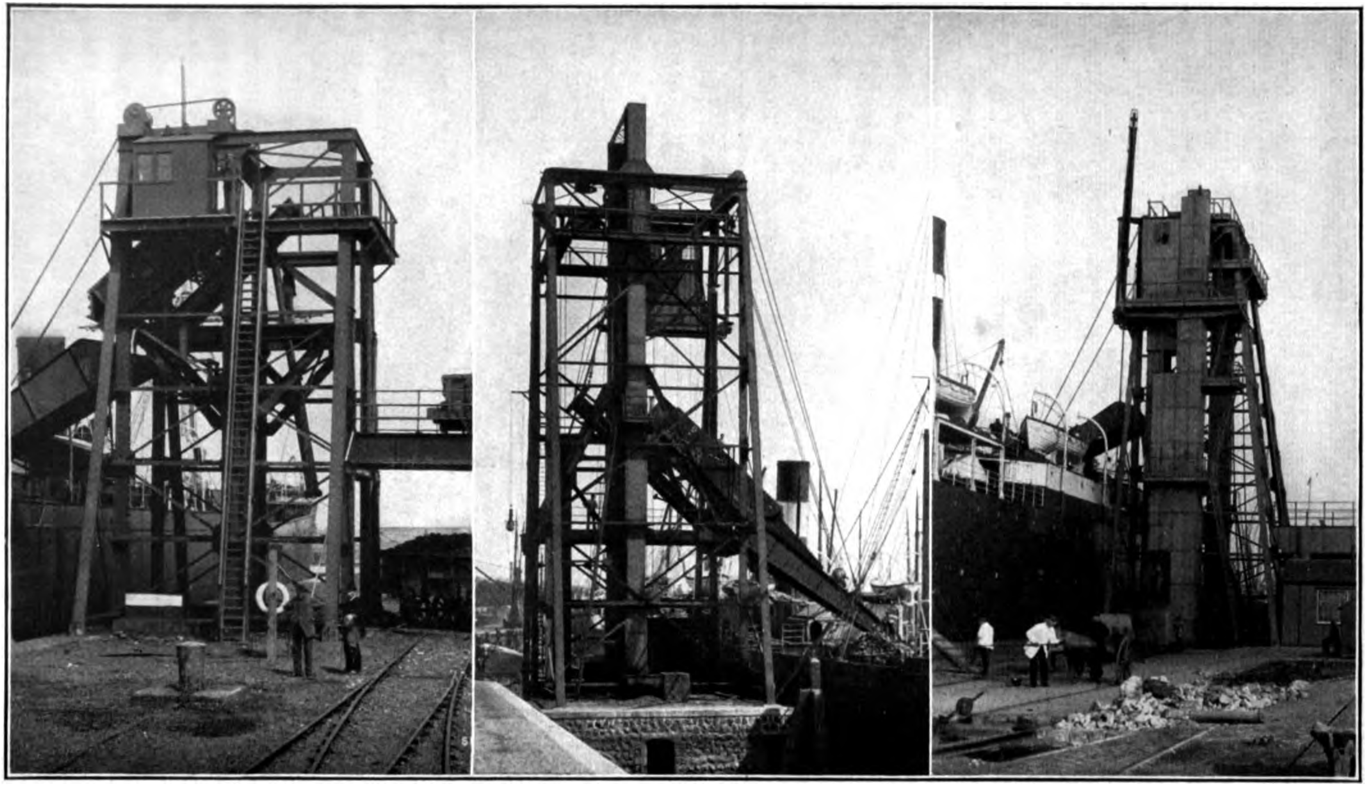
FIXED COALING CRANE, QUEENS DOCK, GLASGOW HARBOUR. LOAD 20 TONS. LIFT 44 FEET.

The illustration just above shows one of four fixed coaling cranes at Queens Dock, Glasgow Harbour. Each can raise loads of 20 tons through a height of 44 feet, and under favourable circumstances can ship in one hour from 25 to 28 wagons each containing 10 tons of coal. These cranes, erected in 1876, and originally worked by three-cylinder hydraulic engines with gearing and cup drums for the chains, were recently converted so that the hoisting and tipping are now effected by rams and multiplying pulleys, the original three-cylinder engines being used only for turning; the range of lift also was formerly only 36 feet. The result of the alterations was a great economy in the consumption of pressure water, quicker speed, and greater range. Formerly the water used in lifting 30 feet, tipping, and turning through half a circle, was 355 gallons, and 13 wagons per hour was the most that could be shipped. For the same cycle of operations the consumption is for hoisting 109, tipping 15, and turning 23, a total of 147 gallons, a saving of 58 per cent.

The efficiency of most cranes for shipping coal is less than that of coal hoists or tips. As a rule, in the former the weight of the cradle, which is about 6½ tons in the case of that illustrated on page 885, cannot conveniently be balanced. In the case of a wagon weighing 6½ tons and carrying 10 tons of coal, the total load would be 23 tons. In a coal-shipping hoist, on the other hand, such as that recently erected at Glasgow, the whole weight of the cradle can be balanced within about 2 tons, so that to ship 10 tons of coal the gross load to be raised would be 18½ tons. In shipping 1,000 tons of coal, therefore, assuming the energy used for tipping to be the same in both cases, the crane would have to lift, slew, and tip a gross load of 2,300 tons, while the hoist would have to lift and tip only 1,850 tons—that is, 450 tons less. If the height raised is 40 feet, the energy saved by the hoist would thus be 18,000 feet tons. Besides, by means of the hoist or tip the work is done much more quickly and by fewer men.

A modern coal-shipping hoist consists of a high steel framework, open at the front and back, the sides being formed with guides for the cradle, which carries a platform onto which the wagon to be discharged is run and upon which it is secured by a chain. The platform is hinged at the front, and by raising it at the back end the wagon can be tipped, at any height, into the shoot. The latter is adjustable to any required height and angle, and can be housed close up to the framing when not in use, by means of the cradle which is provided with levers for carrying the heel of the shoot when moving it up or down. The shoot point is adjusted by chains connected to each side of the cradle.

In the earlier types of coal hoist, shown on page 888, the cradle is raised by two hydraulic rams of different sizes working in cylinders set in a deep well near the edge of the quay, the smaller ram balancing the cradle being always open to the pressure in the mains. The tipping cylinder is fixed to the cradle and oscillates on trunnions, the ram being connected to a pin at the back of the tipping platform. Pressure is conveyed to the tipping ram by a telescopic pipe arranged alongside the cylinders and led through the trunnions, or by walking pipes, but the former is the better arrangement. In a modification of this type some hoists were provided with four rams of different areas, which



HYDRAULIC COAL HOISTS, OF EARLIER AND LATER DESIGNS.

On the left is the early design mentioned on page 887, with the cylinders set in a well near the edge of the quay. The central figure shows the newer form mentioned in the following paragraph, with all working parts above the quay. Both of these were built by Sir W. G. Armstrong, Whitworth & Co. On the right is the suspended-cradle type for high lifts, Princes Dock, Glasgow harbour.

could be used in different combinations so as to adapt the consumption of water to the load to be raised, but it seems rather complicated.

In later designs, in which all the cylinders and other working parts are above the quay and thus admit of such hoists being movable, there are two hoisting rams at each side of the guides in the framing, bearing on a beam to which the cradle is connected. The smaller rams act as balances to the cradle, and being always open to the pressure from the mains, use no water, and the corresponding pairs are arranged diagonally on plan. In this design, the tipping is effected by a cylinder fixed to the side of the framing and a ram with multiplying pulleys, chains or ropes being led over pulleys at the top of the framing and thence downwards to the beam of the tipping platform. Where the range of lift exceeds 40 or 42 feet the rams are sometimes made telescopic, the lower rams being provided with stuffing boxes into which the upper arms work.

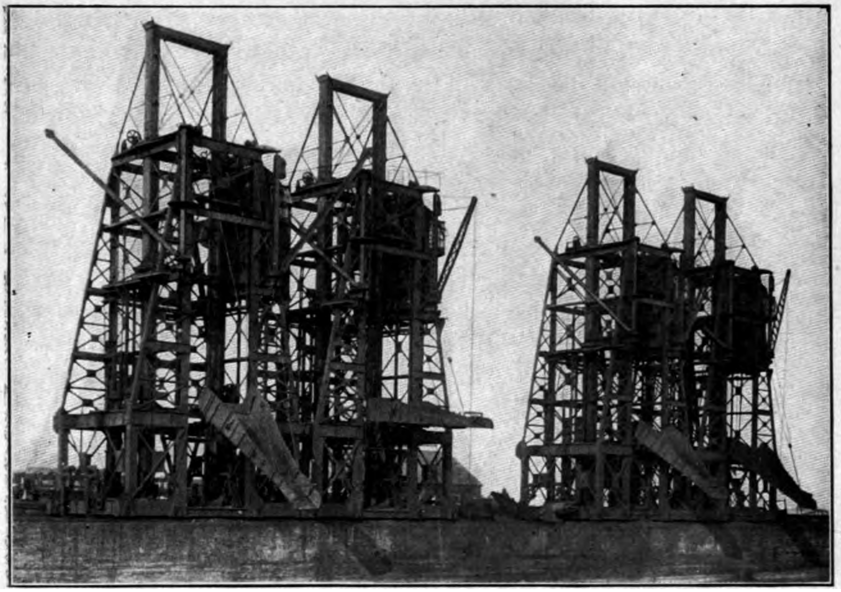
Another design for still higher lifts is the suspended cradle type of hoist, one of which, recently erected at Princes Dock, Glasgow Harbour, and probably the highest in Great Britain, raises loaded wagons weighing more than 25 tons to a height of 50 feet by means of two rams, one for 20 tons, and the other for 5 tons additional. In this case the 20-ton hoisting cylinder with a balance cylinder alongside is fixed to one side of the framing, the rams connected to the same crosshead acting downwards when hoisting, thus assisting to balance the weight of the cradle and enabling their size to be reduced to the least possible. These actuate a set of multiplying pulleys, the chains being led over the top of the framing, passing downwards, and being secured to the cross beam of the cradle, which is thus suspended and which runs in guides on each side. An additional cylinder and ram to lift 5 tons is fixed to the opposite side of the framing, and the chains can be attached to the cradle beam as in the case of the 20-ton lift; but hitherto the latter has been sufficient to deal with any wagons brought to the hoist. The tipping cylinder is arranged in line with and on top of the hoisting cylinder, the ram working upwards and also carrying multiplying pulleys and chains led over the top of the framing to the tipping beam of the platform. The shoot is adjusted by chains temporarily connected to the cradle when required, as already described. This hoist is provided with the usual anti-breakage box and a crane to work it, the box being capable of holding 3 tons of coal. This is used to load about 50 or 100 tons of coal which is lowered into the hold by the anti-breakage crane and piled up in a heap under the hatch, to save breakage when the coal is afterwards discharged direct from the shoot.

Regulating doors, fitted at the point of the shoot, are used for filling the anti-breakage box and for regulating the flow of coal. After being emptied, the wagons are run off the cradle to a high-level inclined railway whence they reach the quay level, descending slowly by gravitation, the gradient being about 1 in 70. In this hoist the speed of lifting is 90 feet per minute, and with a lift of 23 feet 6 inches, 45 wagons, each containing 12 tons of coal, can be loaded per hour. The quantity of water used in raising the cradle with a load of 20 tons to a height of 50 feet in 225 gallons, for a lift of 25 feet 113 gallons, and for tipping to an angle of 45 degrees, 39 gallons.

For quick working the ideal arrangement is that at Barry docks, where the trucks run on by a slight gradient, sloping downwards towards a point about the middle of the hoist, thus giving the least amount of lifting and lowering, and are run off by a similar gradient sloping from the hoist. With this arrangement wagons can be weighed, brought on the cradle, discharged, tared, and run off, at the rate of 60 per hour.

South Wales is the principal centre where coal-shipping machinery of this kind is most used. At Cardiff, Penarth, Barry, Swansea, Newport, and Port Talbot many coal hoists are erected similar to those already described.

At Cardiff there is a very large installation of coal-shipping hoists and cranes. Among the latter, at the Roath dock are eleven sets of the Lewis-Hunter eighteen-ton movable cranes with luffing jibs, ranged along the front of the quay for a length of 1,800 feet and each capable of handling 10 tons of coal at one lift. Behind the cranes is a line of rails running parallel with the quay, with deep pits formed at frequent intervals, provided with hinged platforms on to which the wagons are run. The platforms are lowered at the free end by hydraulic power, and the coal emptied into large iron or steel boxes having pyramidal shaped bottoms which have a connection sliding through the top of the box fixed to a chain operated by the crane. Other two chains acting independently of the first are connected to take the weight of the sides and upper part of the box. When filled, the box is raised, swung on board, and lowered into the hold, being carried by the three chains. When landed, the two side chains raise the box clear of the loose bottom and the coal is slowly emptied by sliding into the hold without any fall whatever. The greatest and only fall the coal can possibly have by this system is 5 feet, when tipped from the truck into the box, and this applies only to the first few lumps, after which it is obvious that as the box fills the fall is reduced until it becomes nil. With the old



MOVABLE COALING HOISTS, PENARTH DOCKS.
Built by Fielding & Platt, Ltd., Gloucester.

system the coal is tipped into a shoot with a fall of 4 feet; it then has to roll down over the shoot, 24 feet long, after which it has an actual drop of between 20 and 30 feet according to the depth of the vessel.

As the box is twice raised during the operation of loading the contents of one wagon of coal into the hold, somewhat more pressure water may be used than by the ordinary coal tip but the gain in the increased value of the cargo by this system will far more than compensate for the difference in the amount of water consumed.

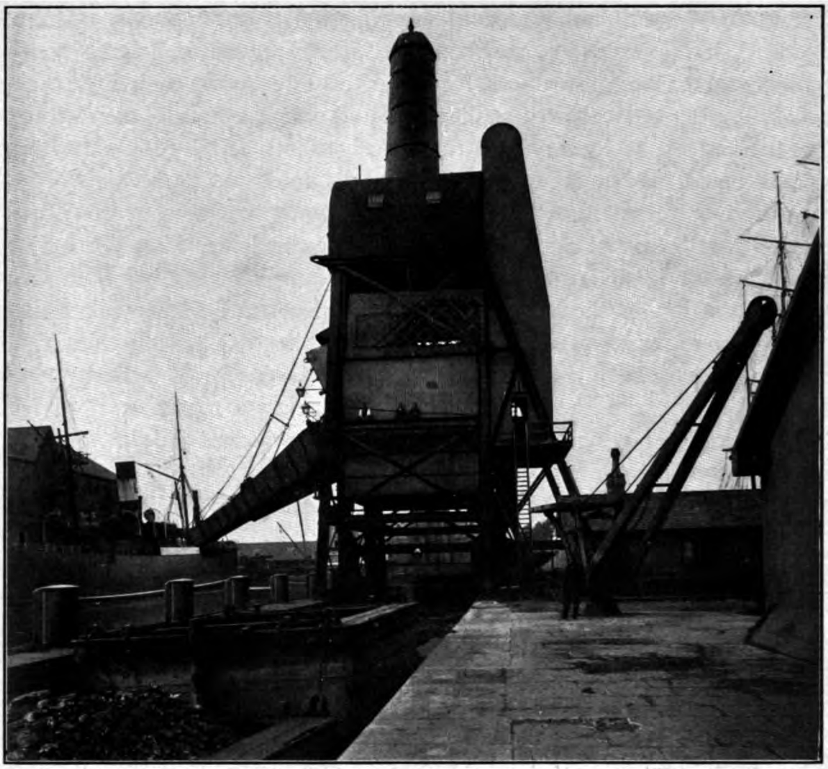
These cranes being movable, three or four can be worked simultaneously, and 9,234 tons have thus been shipped into one vessel, the Samoa, in the net loading time (after deducting stoppages for coal), of 28 working hours, an average of 330 tons per hour, while in the case of another, the Iran, 9,213 tons have been loaded by four cranes in a net loading time of 26½ hours, an average of 347 tons per hour.

A very large dock about half a mile long, 800 to 1,000 feet wide, and 50 feet deep, is now being constructed at Cardiff and the south quay is intended to be laid out for the shipment of coal by the Lewis-Hunter process, the cranes being adapted to deal with 20-ton wagons in lieu of those now in use (10 tons).

At Penarth dock, there is a group of four movable coaling hoists made by Messrs. Fielding & Platt, Ltd., Gloucester and shown in the illustration, which deserve special mention on account of their rapidity of working. These are capable of being rapidly moved to suit the hatches of a vessel by a powerful hydraulic hauling engine. Every part of the machinery in the hoist as well as the cradle, the tipping, working of the shoots, and movement and working of the anti-breakage boxes and crane, is controlled by one man from a high cabin. Each hoist was required to fulfil the following conditions:—A loaded 10-ton wagon having been placed on the cradle had to be lifted 45 feet from the quay, the contents tipped into the shoot, the wagon lowered to the quay level and run off the cradle, within 30 seconds; and this was successfully accomplished. The speed of lifting is 180 feet per second. Each hoist is fitted with two anti-breakage cranes and boxes which are capable of boxing as rapidly as the coal can be delivered into the shoot. Automatic apparatus is provided for stopping the cradle in hoisting and lowering. The shoots are made to radiate 5 feet on either side of the centre line so as to enable them to assist and minimise the trimming. Platforms with two turntables, one for the empty and the other for the full load, with 2-ton capstans at each, are provided for each hoist. The pressure water is conveyed to these tips by means of two mains each 8 inches diameter, so arranged that in case of failure of either one or other it is possible by an arrangement of stop valves and branches connecting them at intervals to cut out any section of these pipes and so turn the water past the defective section. The water is returned through a 12-inch main to the pumping engines. Two large accumulators are fitted on the pressure mains, one at the engine house and the other beyond the tips. The pressure water is pumped by three pairs of compound horizontal tandem engines collectively capable of delivering 1,440 gallons of water per minute, at a pressure of 750 pounds per square inch.

These hoists are specially constructed to enable vessels of 2,000 to 3,000 tons dead weight capacity to enter the dock, be loaded up, and sail the same tide, within a few hours of high water, and are probably the quickest loading coal tips in Great Britain, if not in the world.

Recently some exceptionally rapid work was performed at these tips, no less than three steamers having been loaded with full cargo and bunkers and despatched to sea between 6.40 a. m. and 4.55 p. m. and practically therefore on one tide. The Gatesgarth commenced at 6.40 a. m. and took in 2,291 tons—there was the usual half-hour interval for breakfast, and the work at commencement was comparatively slow owing to the frost—but the vessel completed her cargo and bunkers at 10.20 when she was hauled out of berth. The Dalegarth then



HYDRAULIC BARGE HOIST FOR SHIPPING COAL, GOOLE, YORKSHIRE.
ELSWICK-BUILT.

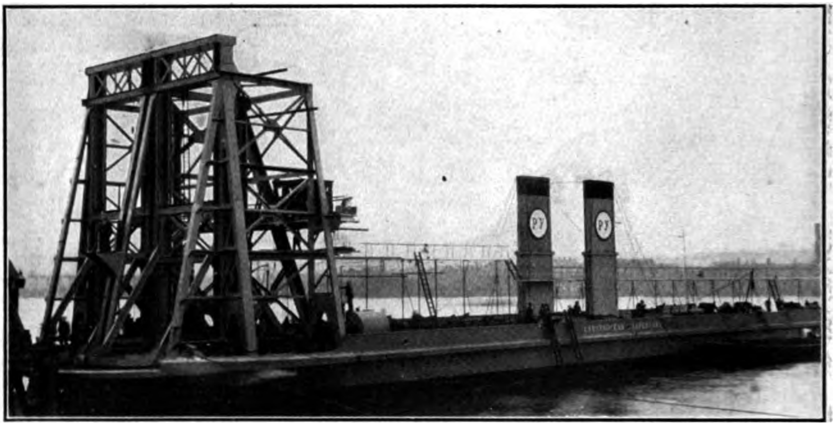
went into berth, commenced loading at 11.05 and finished both cargo and bunkers (2,201 tons) at 1.55 p. m. She then made way for the Throstlegarth, which commenced loading at 2.15 and took in her full complement of cargo and bunkers (2,107 tons) by 4.55 p. m.

As each steamer before commencing cargo took some time in shipping her bunker coal, which could only be shipped over one tip, the time of actual loading was appreciably less than the foregoing figures indicate.

The aggregate quantity shipped at this one berth between 6.40 in the morning and 4.55 in the evening was thus 6,599 tons, and some idea may be formed of the labour thereby entailed when it is stated that in addition to haulage to and from the tips, 676 wagons had to be lifted to a height of 30 feet above the level of the quay and returned to the quay level.

At Goole, in Yorkshire, there are three barge hoists worked by hydraulic power, similar to coal-shipping hoists for wagons. These are shown on page 893 and are used for tipping coal from compartment boats into steamers for export. The boats, each of which holds from 23 to 25 tons of coal, are floated onto the cradle, then lifted, and turned over sideways, so that the contents fall into a shoot by which the coal is conducted into the vessel's hold.

Another interesting example of wagon hoist is shown in the illustration just below of a steam ferry boat for the River Volga for taking trains of loaded railway trucks across the river. Owing to the great variation in the water level it was necessary to provide some arrangement for transferring the trucks to the barge from the fixed railway approaches on the shore, and this was done by means of two hoists fixed on the end of a barge, each having a cradle worked by hydraulic power which can be raised to any required height, and on which the trucks are run one by one.



VOLGA FERRY WITH HYDRAULIC HOIST FOR RAISING RAILWAY TRUCKS TO THE LEVEL OF THE SHORE APPROACHES. BUILT AT ELSWICK.

Hydraulic power is convenient, reliable, easily controlled, and is thus admirably adapted for dealing with very heavy loads such as canal lifts, floating docks, and bridge-building and working machinery such as that already referred to; also for heavy forging work, stamping presses, flanging, rivetting, and plate-bending appliances. Hydraulic cranes, hoists, and capstans are efficient and economical when working at the full loads for which they are designed, but efficiency falls off rapidly as the loads become less. It should be noted that in cranes as much water is used to lift the empty hook as to lift the full load, and in capstans the same quantity of water is used whether the capstan is running idle or pulling ten or twelve loaded wagons. Although attempts have been made to get over this difficulty by making the cranes compound, as described on page 889, by using telescopic rams for two or even three powers, except in special cases these are only a makeshift. It is not convenient to have to change from one power to another to suit the various loads, especially when this has to be done in the dark, and frequently, rather than change to a lower power, the crane driver keeps using the larger one, thus wasting water. The same remarks apply to coal-shipping hoists, where in Great Britain loaded wagons vary in weight from 13 to 25 tons. Capstans use a lot of water and are very inefficient at low powers, that is with light loads, such as hauling single empty wagons. Some attempts have been made to reduce this loss by making the capstan head of two different diameters, but these have been found inconvenient.

Chiefly on account of this loss of efficiency and of damage to hydraulic plant by frost during winter in the more northern latitudes, and also on account of the greater difficulty of handling hydraulic connections and the greater cost of their maintenance, electric power is now very largely coming into use for working cranes, capstans, and other dock equipment. The cost of power used in discharging, say 1,000 tons of cargo by hydraulic cranes, increases in inverse proportion to the loads raised; that is, the smaller the loads the greater the cost for power. In loading the difference is still greater in favour of electric power for, while by the hydraulic crane the cost would be the same as for discharging the same quantity of cargo, the cost of loading by an electric crane of the same power would be, roughly speaking, from one-half to one-third of that of the hydraulic crane, because in loading, the empty hook would be raised as much as the loads would be in discharging, and for this the maximum power would be used by the hydraulic while the minimum would be used by the electric crane. In this connection it is worth while to remember that 1,000 gallons of water at 750 pounds per square inch used per hour is the equivalent of 6.52 units of electricity. Again, if it be desired to compare electric with hydraulic power as used in any of the appliances referred to, a useful formula is $WH = G \times P \times .0087$, i. e., the watt hours per cycle = gallons used per cycle multiplied by the hydraulic pressure per square inch $\times$ .0087.

Whatever may be the future of hydraulic power, it is quite certain that for many purposes it will still be more suitable than electric power.

The author desires to express his thanks to Sir W. G. Armstrong, Whitworth & Co., to Messrs. Fielding & Platt, Ltd., and to Messrs. Fullerton, Hodgart & Barclay, Ltd., for the use of photographs.

LABOR-SAVING MACHINERY IN FOUNDRY OPERATIONS.

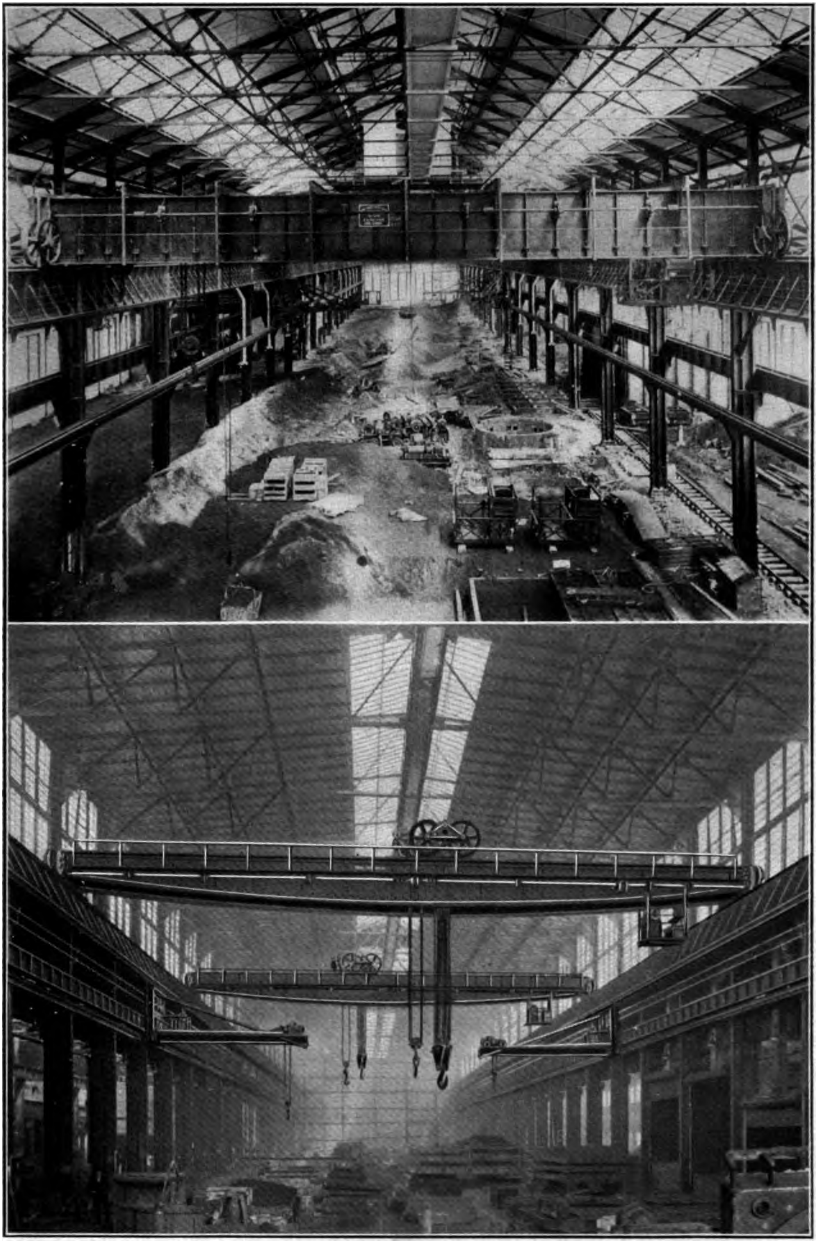
By Dr. R. Moldenke.

Dr. Moldenke's text and the accompanying illustrations are ample to show **that there is** no lack of labor-saving machinery applicable to the foundry, and some **progressive foundries** where every advantage of this sort is seized. In the main, however, the foundry **appears the** least advanced of the metal trades. Dr. Moldenke makes a very practical, logical, **and orderly** presentation of the money-saving possibilities which are open in this line.—THE EDITORS.

It may as well be freely confessed at the **outset,** that we have still much to do in the way **of installing** labor-saving devices in the foundry. **Yet** what has been done already plays so **important a** *rôle* that the effect is readily seen when it **comes** to compare quotations for work received **from** competitive shops.

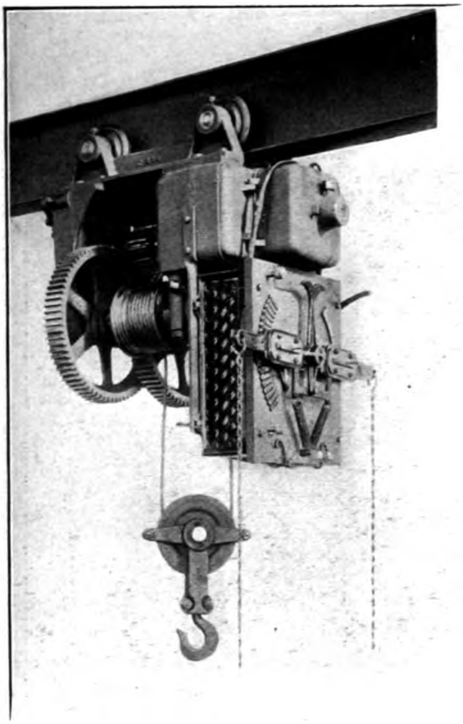
Two things there are which militate against **the** general introduction of labor-saving **appliances** in the foundry industry:—these are the **active** hostility of the labor employed, which sees in them a **means** to cutting down earnings, and the inertia of the foundryman **himself,** who hates to be forced out of the beaten path. These two **points,** which are all-important in connection with what is to follow, **deserve** a little further ventilation.

The laborer who earns his dollar and a half a day does **not care** much whether he is wheeling sand or preparing the loads for **the** electric traveler. The skilled moulder, however, does care, if **this** laborer is placed at a moulding machine, which reproduces the **moulder's** own particular work at a little over half his pay. Hence **his** opposition. Strike after strike can be placed to the account **of the** moulding machine. Where the management of a "union" **shop has** had the temerity to insist on using this labor-saving device, and **either** forced or by other means secured its retention in the shop, **straightway** is the production limited to something like a day's work **by hand.** The owners of the "open" shop naturally reap the advantage, as **they have** a goodly string of "Hungarians" waiting an opportunity **to manipulate** a machine. As a natural consequence, the "open" shop



CRANE EQUIPMENT FOR THE FOUNDRY. OVERHEAD TRAVELERS AND AUXILIARY JIBS.

Above is shown a general view of the crane arrangement in the Westinghouse foundries at Trafford City. The cranes are by Wm. Sellers & Co. Below is the main foundry of the Allis-Chalmers Co., with Pawling & Harnischfeger cranes. The large travelers are each of 40-tons capacity, with 10-ton auxiliary hoist.



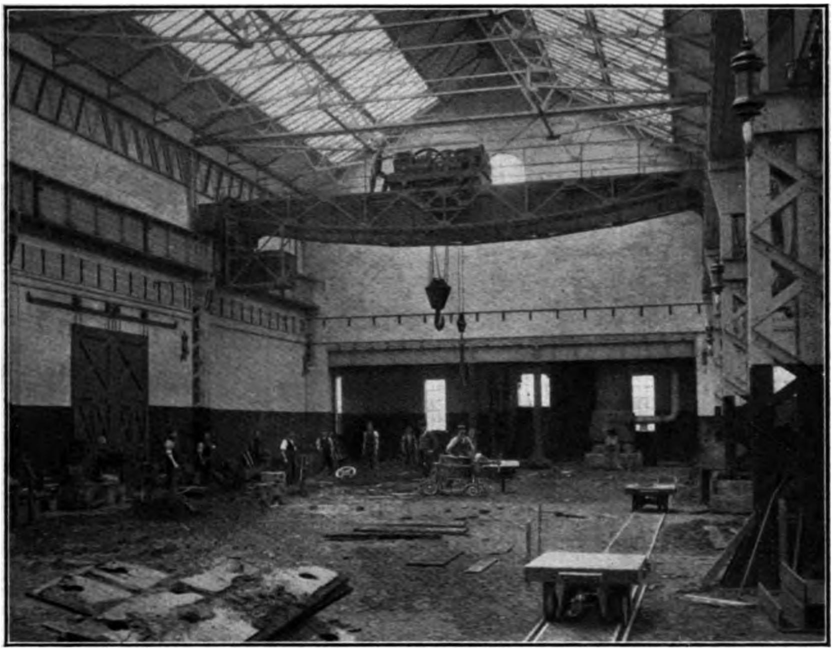
will hereafter be less of a curiosity; all the signs point that way. The governing body of the Moulder's Union has gone on record in favor of the moulding machine, demanding, however, that their members be used to bring out "its best possibilities." More need not be said on that question.

On the other hand, the foundryman of the generation just passing has been most slow to act. He is afraid of improvements, even though he sees his margins being cut down by keener competitors, who do not hesitate to invest in whatever means labor saving. It is a sad commentary of the times that the associations of foundrymen which make education their principal object, and thus equip their members for industrial leadership, are starving; while the trade organizations to fight labor, instead of educating it up, have "funds to burn." The managers of the coming generation, if educated properly along technical as well as business lines, will act differently, and from them we await the advance in the industry which labor-saving devices used in their fullest development alone will give.

The practical application of the foregoing would seem to lie in the joining of effort on the part of associated bodies which oppose the organized tyranny of labor with those whose aim is to

2-TON ELECTRIC OVERHEAD TROLLEY HOIST AND GEARED CRANE LADLE.
Northern Engineering Works.

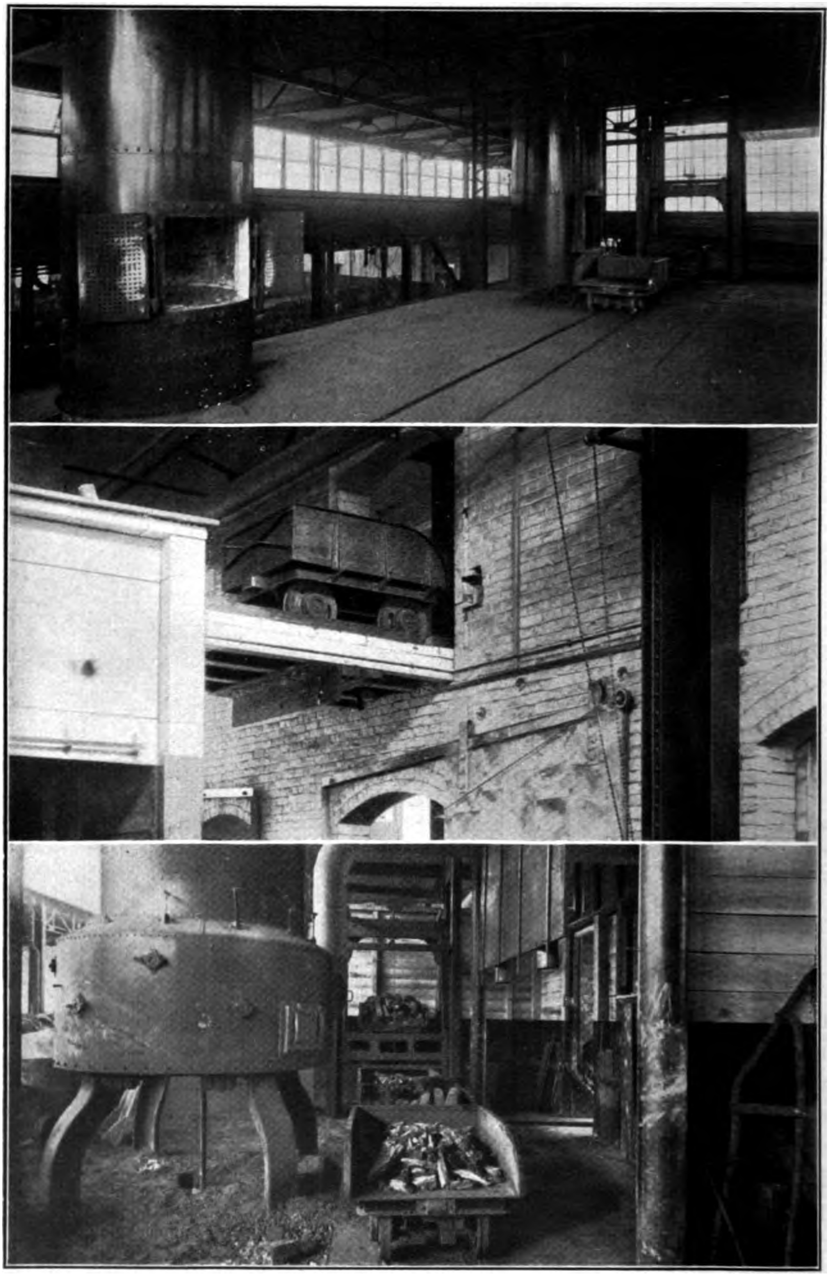
educate both labor and owners. Only by taking away the power for mischief from the ignorant, and giving the intelligent individual a chance to better himself by his own effort, will conditions be brought about which are at once tolerable and fair.



INDUSTRIAL RAILWAY IN THE FOUNDRY OF THE BRITISH THOMSON-HOUSTON CO., LTD., RUGBY.

The ladle cars are used for transporting melted metal, and the flat-topped cars for handling pig iron and castings. The C. W. Hunt Co., West New Brighton, N. Y.

The first place to look for labor-saving devices is in the yard arrangement of a foundry. Recent examples as well as old establishments remodeled are so arranged that raw materials enter, and products leave, with as little handling as possible. When coal, coke, sand, and the like can be dropped through a trestle into bins, and be subsequently taken away through chutes directly into industrial cars, an important economy will have been affected. Pig iron, if thus dropped from a trestle for piling below—or better still, if thrown from the car directly upon the charging platform, and used—would require a minimum of handling. This, however, is possible only in small institutions. The larger foundries must pile up a considerable stock of pig iron. There are still "back numbers" where the cupola charges are passed up hand to hand, but the majority of American foundries are



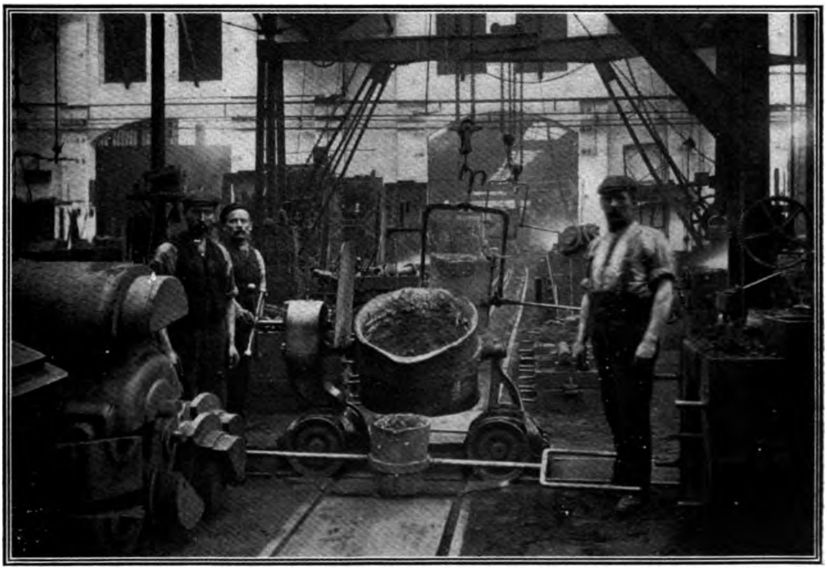
CUPOLA-CHARGING SYSTEM, HYDE PARK FOUNDRY OF THE B. F. STURTEVANT CO.

At the bottom are seen the cars, ready to go up to the charging floor. In the middle is one of the charging cars just passing between the elevator and the charging floor. At the top is the charging floor, with the car at the cupola-charging door.

now equipped with hoists or elevators. When the quantity melted is, say, 25 tons daily, a single hoist, run by hydraulic power, serves very well. Where 50 tons and more is the rule, a double, balanced, electric or steam elevator is preferable.

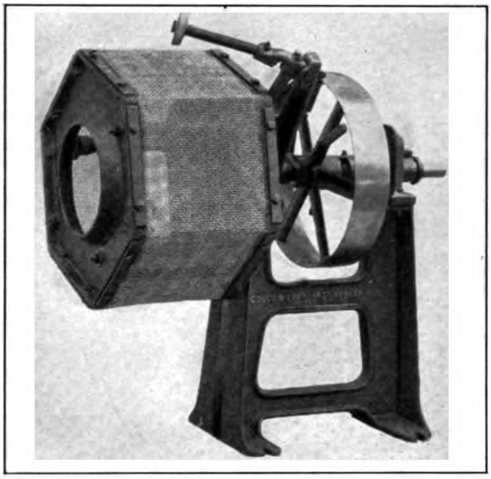
To show what is done in the way of labor saving in the metal yard, the following instances are cited. One establishment uses a very large traveler in the yard, covering all the piles of pig iron. This traveler is used to pick up the irons for the mixture, putting them into a series of buggies. A string of these is then pulled up an inclined plane along the side of the foundry, upon the charging platform. This, while somewhat roundabout, is still a very effective labor-saving device. It would be better yet to lift the charges upon an extension of the charging platform covered by the crane, and then transport the cars to their destination.

Another instance is that of the new Allis works in Milwaukee, where a similar yard crane takes up the pig iron and scrap and loads it into portable hoisting skips; these are then shot up directly in front of the cupola door, and the contents tilted in. The practice is strongly suggestive of blast-furnace methods, and it is stated that the melting is quite uniform. Perhaps it might be a good idea to add to all these systems a crane scale to weigh the iron picked up, and to do the



HUNT'S LADLE CARS AND INDUSTRIAL RAILWAY, IN THE FOUNDRY OF RUSTON, PROCTOR & CO., LINCOLN, ENGLAND.

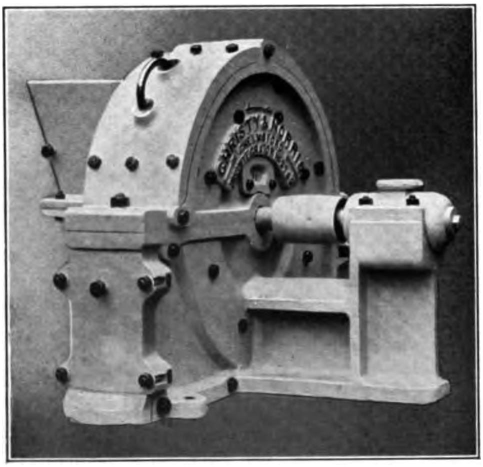
The C. W. Hunt Co., West New Brighton, N. Y.



EBERHARDT'S AUTOMATIC SAND SIFTER.

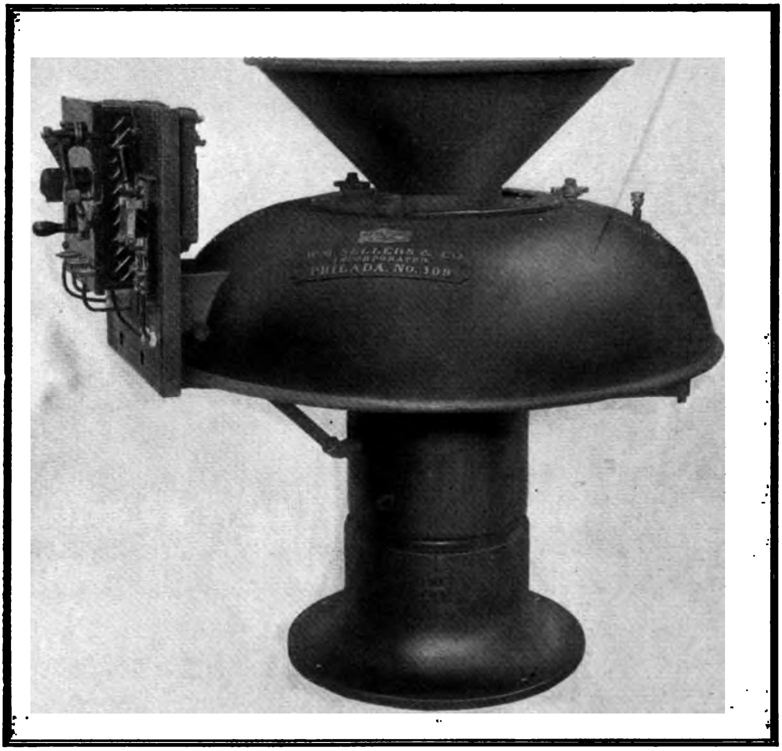
picking up with a large electromagnet, such as is used in some of the large sheet mills. A minimum of labor would be then required for the preliminary foundry procedure.

Even in the manufacture of sash weights we find metal conveyors used. It seems incredible that just this advanced method should prevail in the shops which act as the scavengers of the foundry industry. Yet we see tin cans, etc., slowly wending their way upward, and directly into the top of the cupola, alternating occasionally with fuel and flux, and this going on continuously. Almost a constant stream of metal comes from the cupola spout, and is poured into the most primitive of moulds, four or five men turning out a lot of tonnage, and the metal containing nearly every common metal under the sun. Occasionally we see this system used also where heavy tonnage is required for but little moulding, as for instance in the manufacture of ingot moulds. A chain conveyor which takes up the single pigs into the door of the cupola is quite a labor-saver, the coke usually being sent up another way.



DISINTEGRATOR FOR FOUNDRY USE.
Christy & Norris, Chelmsford.

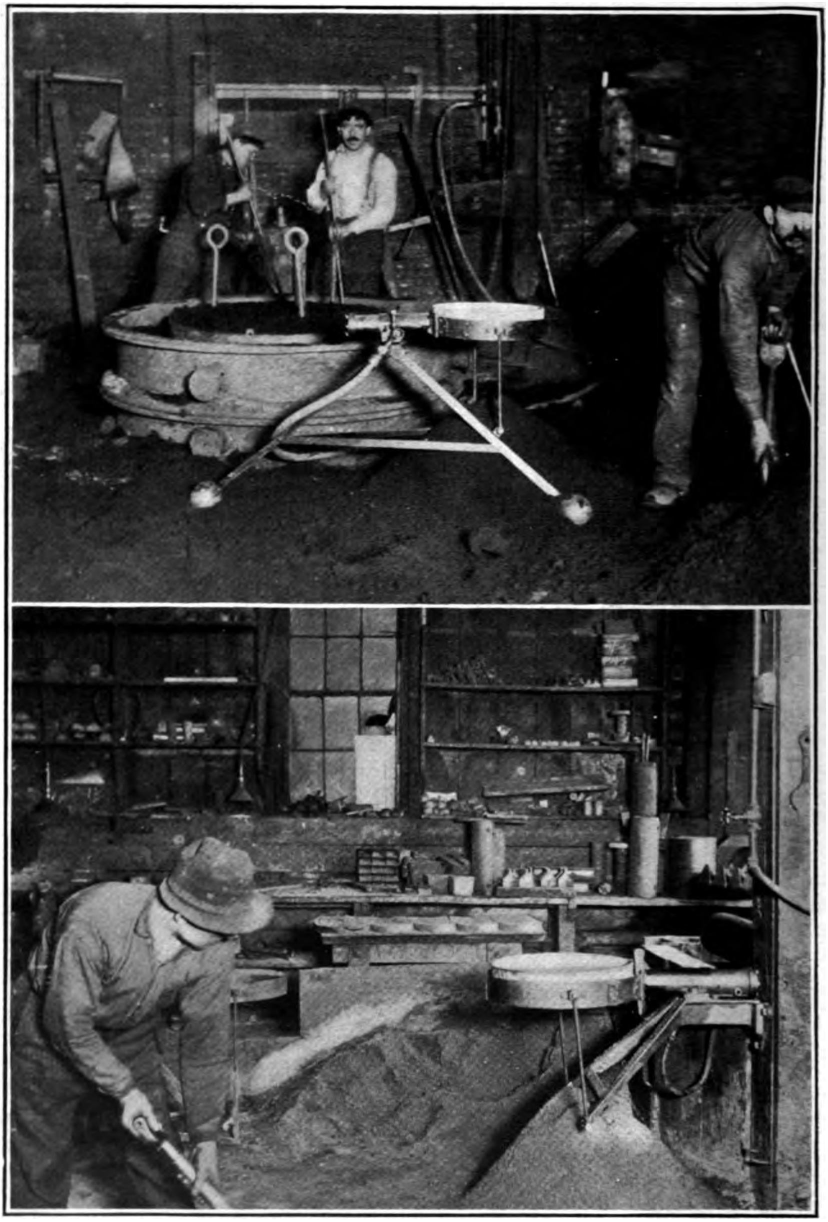
From the yard, so arranged that interference between incoming and outgoing material is avoided as much as possible, and the most economical distribution of the stock is obtained, we come to the general arrangement of the buildings. Here also much labor can be saved by making the course of the material through the shops a most direct one. Wherever possible the industrial-railway system should be used, and if standard-gauge railway facilities are at hand, a spur right into the main foundry is a money saver. All important shops now have this, and castings are lifted from the floor by the crane, weighed on it, and deposited for shipment without rehandling. Turntables at all crossings should be provided, so that the system of trackage in the foundry and adjacent buildings may become as flexible as possible. Large industrial establishments are now introducing the electric locomotive, and the future will see some of these in our foundries also. It goes without saying that plenty of light, air, and heat in winter, also constitute a valuable asset in any establishment, being in fact labor savers.



MOTOR-DRIVEN CENTRIFUGAL SAND MIXER.

Output about 5 tons an hour, and of better quality than can be obtained by any system of hand mixing. Wm. Sellers & Co., Philadelphia.

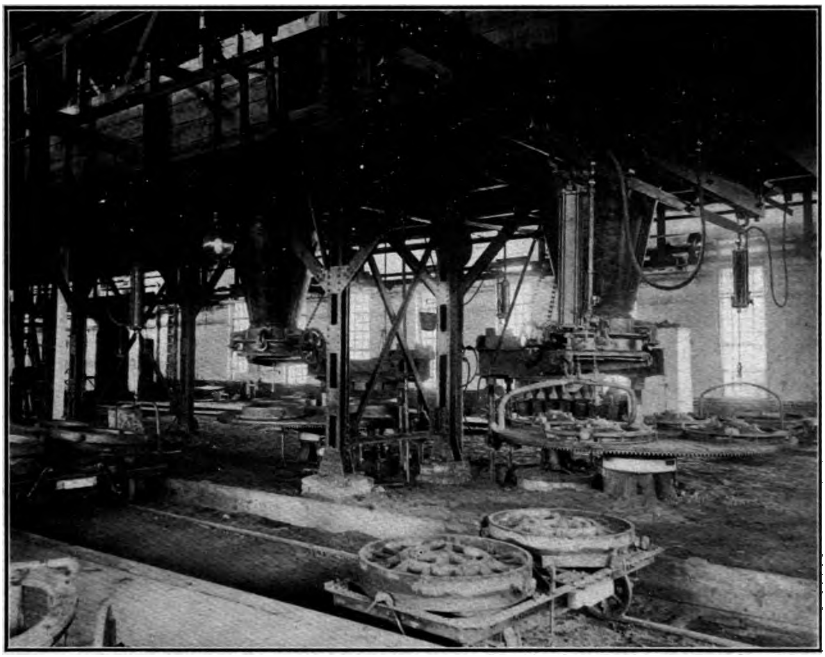
Coming now to the moulding department proper, we still see in most foundries the old way of tempering the moulding sand. Occa-



THE HANNA PNEUMATIC SCREEN SHAKER, TRIPOD AND POST TYPES.

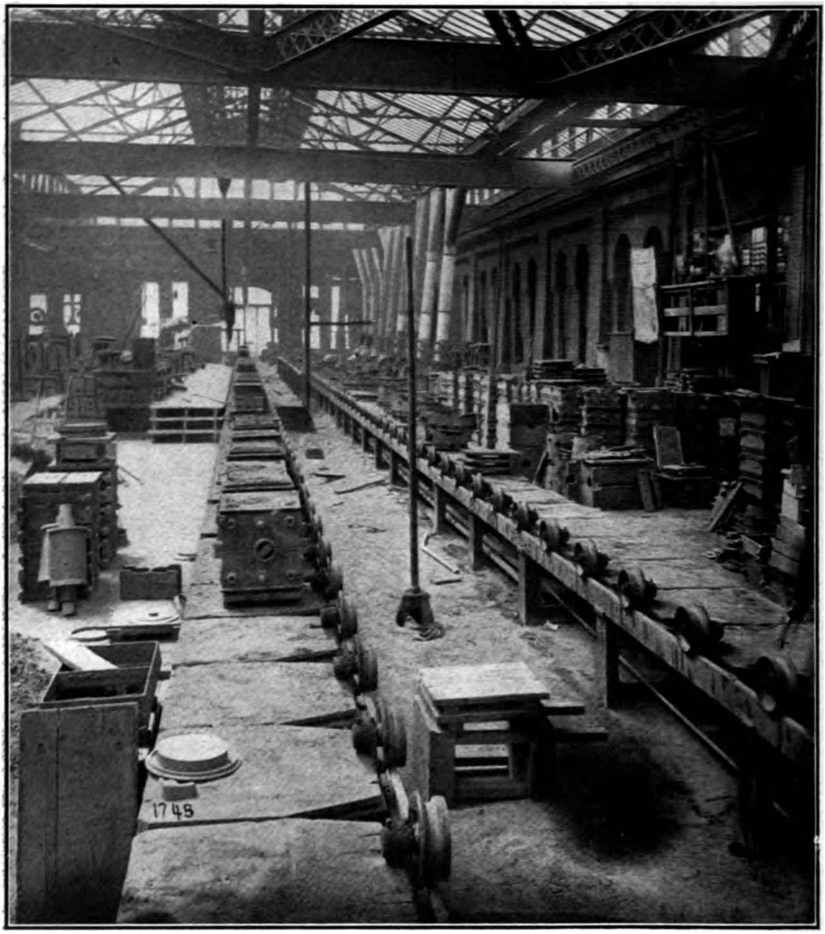
Especially adapted to shops where the work is too diversified to allow of central screening. A valveless piston, working in a cylinder, is attached directly to a holder arranged for an ordinary 16-inch riddle. Uses about 12 cu. ft. free air per minute at a pressure of 80 lbs. Hanna Engineering Works, Chicago.

sionally we find an establishment where a centrifugal mixer improves on this hand tempering, at least for the better grade of castings, and for all the sea-coal facing mixtures. The reduced scrap heap of the trimming room soon gives evidence of the wisdom of this additional treatment. Then we find also automatic sand sifters, usually run by pneumatic power and in connection with a moulding machine, which are also wonderful labor savers. They imitate closely the action of a man riddling the sand pile.



SAND-HANDLING PLANT, TERRE HAUTE WORKS, AMERICAN CAR & FOUNDRY CO. MOULDING END.

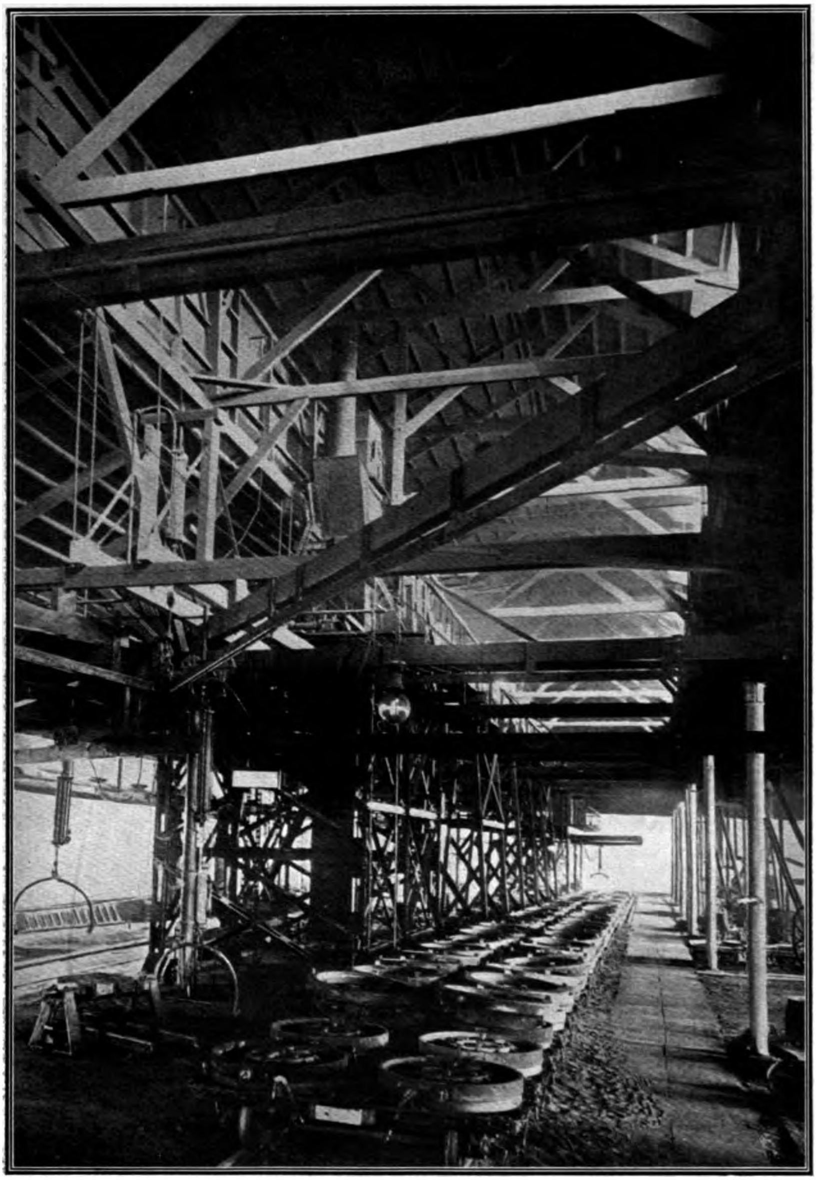
It is in the specialty shops that we must look for the greatest advance along this particular line. Several works of importance have systems so complete that only the dumping in of new sand is done by manual labor. Here is an outline of the general arrangement:—The sand from the castings just dumped out, usually taken to the end of the system and thus cooled a little, passes through a screening machine to take out the lumps, iron shot, etc. The addition of iron bars tumbling around with the screen helps to break up many of the lumps and thus saves working them up subsequently. As the sand comes from the screen it is wetted down with a measured quantity of water, and then passed through a centrifugal mixer. The tempered sand



PART OF CONTINUOUS MOULDING SYSTEM, WESTINGHOUSE AIR-BRAKE COMPANY'S FOUNDRY.

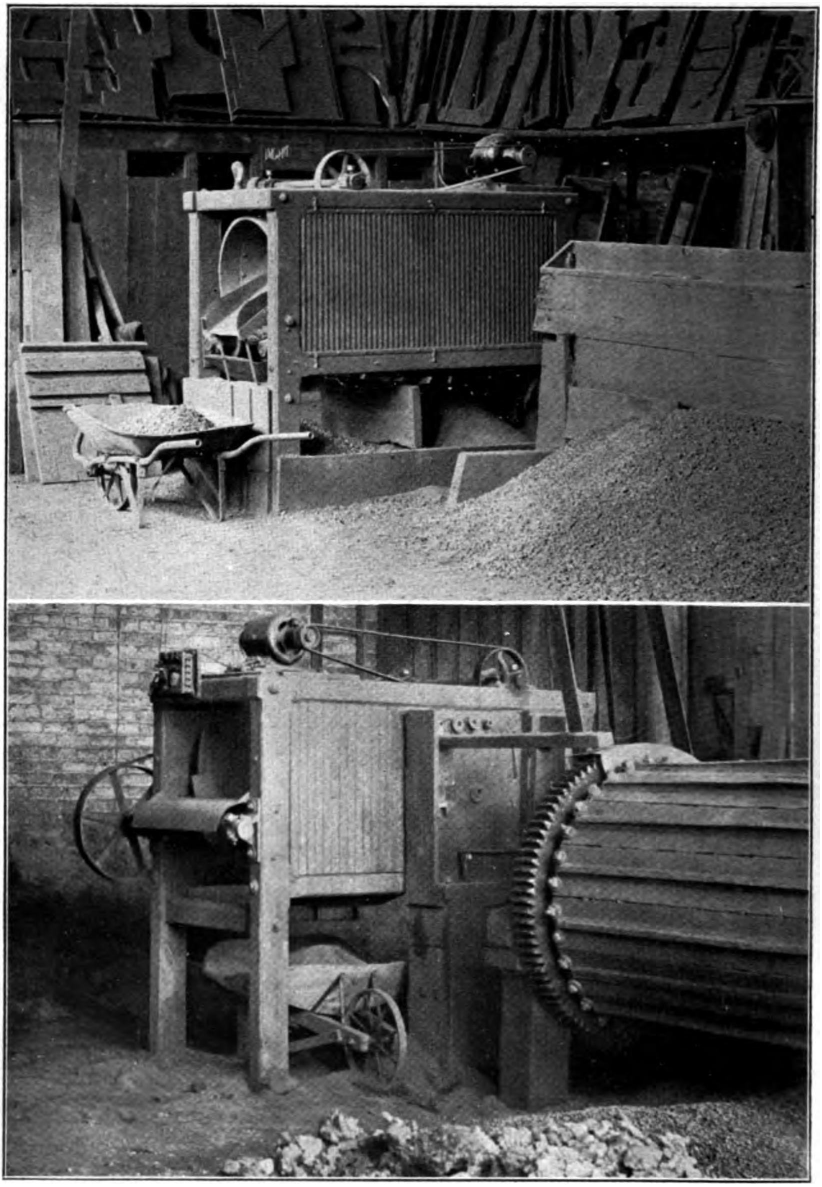
237-foot center conveyors, single-strand chain, sprocket-wheel terminals. The sand is elevated to overhead conveyors and delivered to chutes seen in the right background, leading to the moulding tables. The mould being made, the flask is placed on the conveyor, passes to the pouring station near the cupola, and thence at a low speed, cooling as it goes, to the other terminal. There it is emptied upon screen bars, the sand passing through and eventually back to the elevating and conveying machinery. Link-Belt Engineering Co., Philadelphia.

now goes into a bucket conveyor which takes it up to the distributing level, over the moulding floor. Here it is dropped into a reciprocating conveyor, which gradually passes it over the chutes from which the moulding machines or moulding floors are supplied. This system, with but little modification, is in operation in several places. It could



SAND-HANDLING PLANT IN CAR-WHEEL DEPARTMENT, TERRE HAUTE WORKS, AMERICAN CAR & FOUNDRY CO.

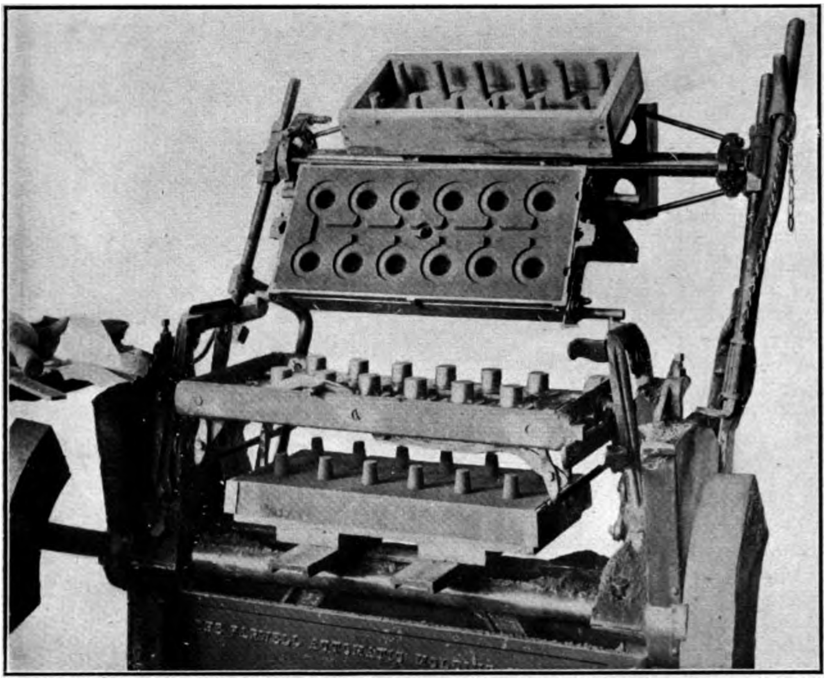
Installed by Heyl & Patterson, Pittsburg, Pa. The purpose of the plant is to provide a continuous moulding system, the moulds being conveyed from the moulding machines to cupolas where they are poured, and thence, cooling as they go, to a point where they are shaken out. Here the sand is automatically dumped, tempered, screened, and returned by a conveyor to the moulding machines for re-use. This view shows the shake-out end.



DINGS MAGNETIC SEPARATOR FOR FOUNDRY USE.

The lower view, taken in the Allis-Chalmers South Foundry, shows the feeding end. The machine is used for recovering iron from cinder-mill droppings, rattle-mill droppings, gangway scrapings, chipping-iron refuse, etc. It takes the material as fast as a man will ordinarily shovel it in. The upper view, from the foundry of Wm. Bayley & Sons, Milwaukee, shows the delivery end.

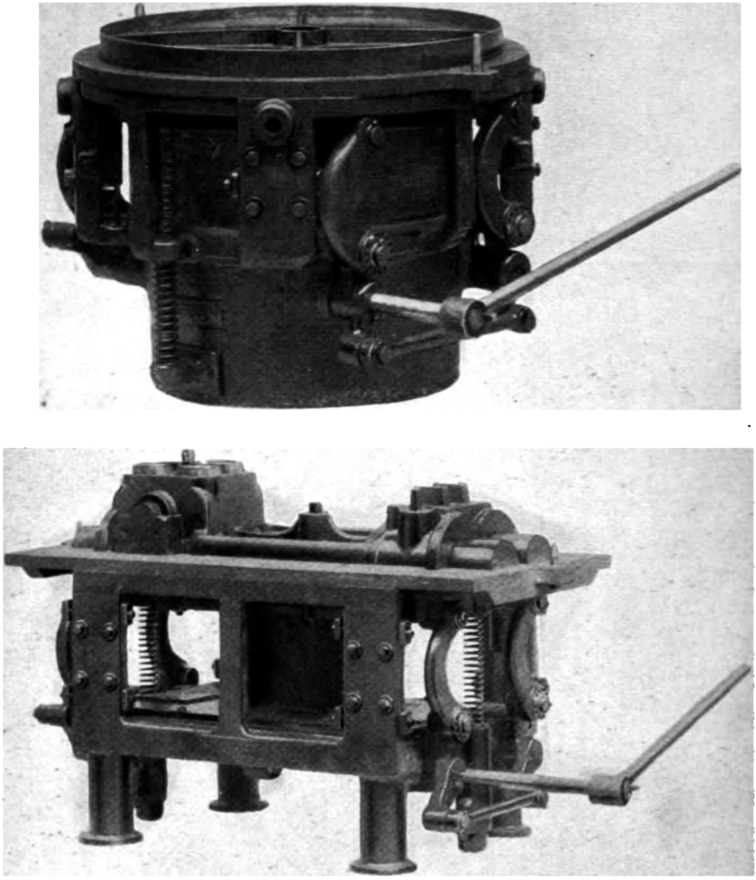
be effectively extended by the introduction of a magnetic separator just after the hot sand drops through the grating, and before it goes into the sifter. In fact, it is a question whether the introduction of a pair of rolls after the magnetic separator is not an improvement, as this does away with all subsequent manipulation of the lumps of baked moulding sand. The burnt and worthless sand goes away, attached to the castings, and is rolled off in another operation. The larger core parts might bother the system, and spoil the sand; but these can be caught on the grating and slid away.



FARWELL AUTOMATIC MOULDING MACHINE.
The Adams Co., Dubuque, Iowa.

The electromagnetic separator is a money-maker in any foundry. In all cases coming under my observation, they have paid for themselves three months after installation, the only necessity being to use the recovered shot properly in the mixture. Some day we may see the old dump heaps of foundries—at least in the Western United States—gone over by Chinamen with such a machine, and great will be the saving.

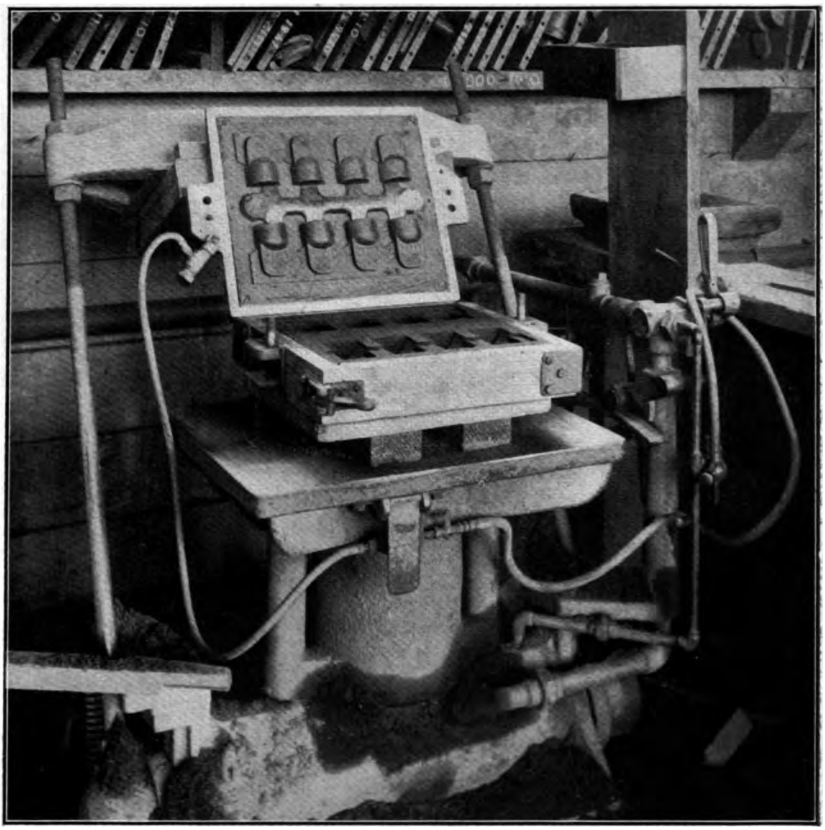
Now we come to the moulder, and the labor-saving devices with which he may increase his output effectively. Pounding sand is about



PRIDMORE ROUND AND SQUARE DOUBLE-SHAFT MOULDING MACHINES.

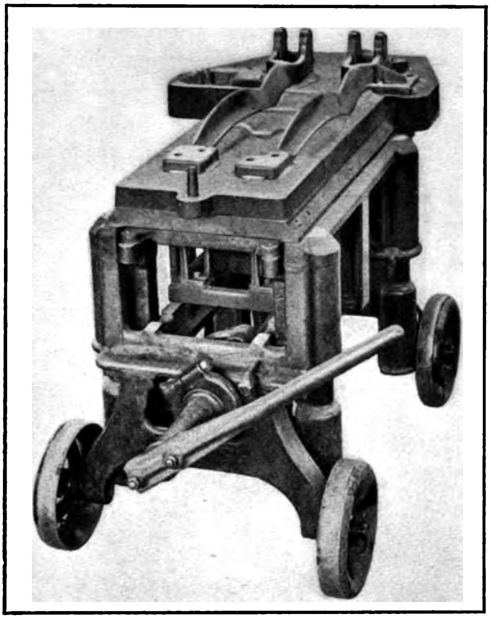
the most laborious work in any industry. At the end of the day, a moulder who has done his full duty is more fagged out than the navvy digging sewers. It requires muscles of steel to keep up the pace, as well as agility and precision. Every move must be made to count where intricate work is made in quantity. Very few moulders really work with method, and hence they make their occupation more laborious than it should be.

The pneumatic sand rammer is intended to relieve the moulder of much of this back-breaking work. Both the hand rammer and the portable machine for heavier work are very efficient, compressing the moulding sand evenly and uniformly at the rate of two hundred blows and more per minute. The importance of this device is seen in shops where much heavy work is done. It sometimes happens that several men spend a week or more moulding up one piece in the floor, probably nine-tenths of the time being spent in pounding the sand. A couple of these pneumatic rammers can easily cut this time in half. The result is the doubling of the output for the shop, so far as that class of work is concerned. Yet how very few of these rammers do we see in use in foundries. Wherever they do go in, however, they are bound to stay. Again, in repetition work this rammer is very useful; where (for instance) a casting similar to a journal box for car work is made by the hundreds daily, the simple pounding



VIBRATOR FRAME MOULDING MACHINE, BRASS FOUNDRY OF GENERAL ELECTRIC CO., SCHENECTADY.

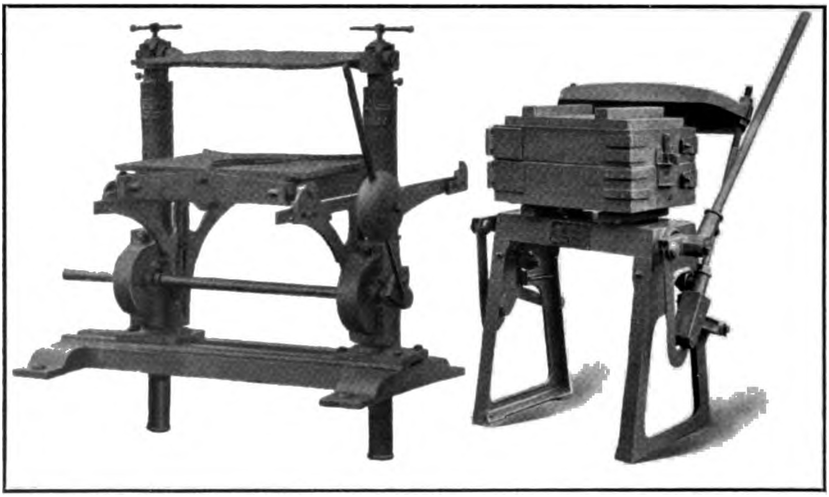
Patterns are machine-moulded by attachment to wooden boards boiled 10 hours in paraffine. These boards are then fastened in the detached vibrator frame of the machine and moulded as shown. Tabor Mfg. Co., Philadelphia.



PORTABLE MOULDING MACHINE.
Arranged with mechanism which keeps stripping-plate patterns constantly up to their proper height.
Tabor Mfg. Co., Philadelphia.

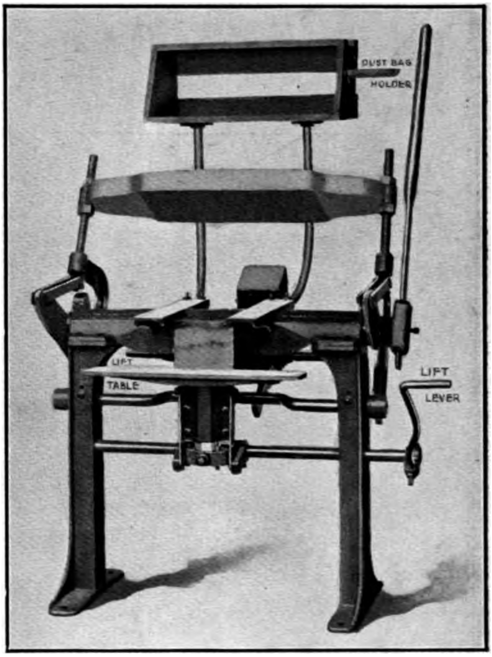
of the sand can be done much more quickly than by hand, and with just as much judgment.

The next step brings us to the moulding machine, than which no device has been more epoch-making in the foundry. From the simple "squeezer," or hand press, to the most complicated universal machine, which is made to perform successively each separate step in the cycle of mould-making on a number of moulds arranged on a revolving table, we have any number of mechanical constructions. Each machine is a money maker when used on the class of work for which it is specially adapted, but a disappointment when applied to any other.



HAND PRESS MOULDING MACHINES, MANUFACTURED BY SAMUELSON & CO., LTD., BANBURY, ENGLAND.

To see a moulding machine, with its complement of men, turning out one thousand three hundred moulds in ten hours where formerly the same pattern was good for only one hundred and fifty, must show the enormous capabilities of this labor-saving device, when judiciously applied. With a net gain of only 50 per cent. over hand work, any intelligent business man would be expected to jump at the chance of installing these machines. The introduction, however, has been most slow, both on account of the labor opposition, and the mistakes of application made by the pioneers in the business, now happily more successfully avoided.



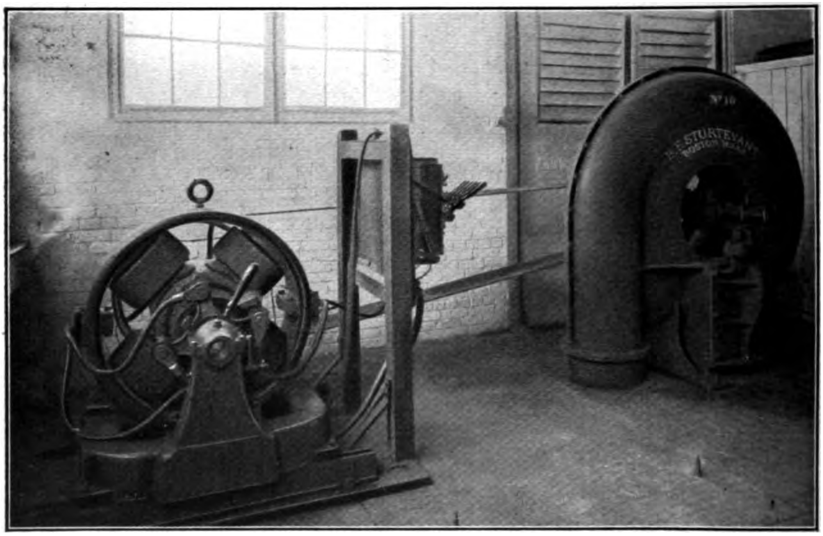
FARWELL UNIVERSAL MOULDING MACHINE.

May be used as combined moulding press and stripping-plate machine, as combined moulding press and flask lifter, without stripping plate, or as a plain moulding press. The Adams Co., Dubuque, Ia.

It would carry us too far to go into details along the lines of moulding-machine construction. Suffice it to say that these machines are made to run by hand, pneumatic, and hydraulic power. They may be provided with stripping plates to hold the sand properly from falling when the pattern is drawn, or they may use the vibratory rapping which gently disengages the sand from the pattern while it is drawn without the aid of the stripping plate. They may have the mould made and taken away in various ways. They may be fully or only partially automatic. The moulds may be made singly in iron flasks, or in snap-flasks which leave the blocks of sand free for subsequent manipulation before pouring. Or these blocks of sand may be ranged together in large floors showing only the pouring gates. Then come the special machines for moulding gear wheels, curved pipe, etc., and latterly much large dimension work, formerly thought impossible to make otherwise than by hand.

Five years ago this could not have been written, and even now we are in the transition period in this respect, the pressure of competition gradually forcing the owner to adopt, and the workingman to yield his opposition to, these most useful machines; if he does not, he must go under.

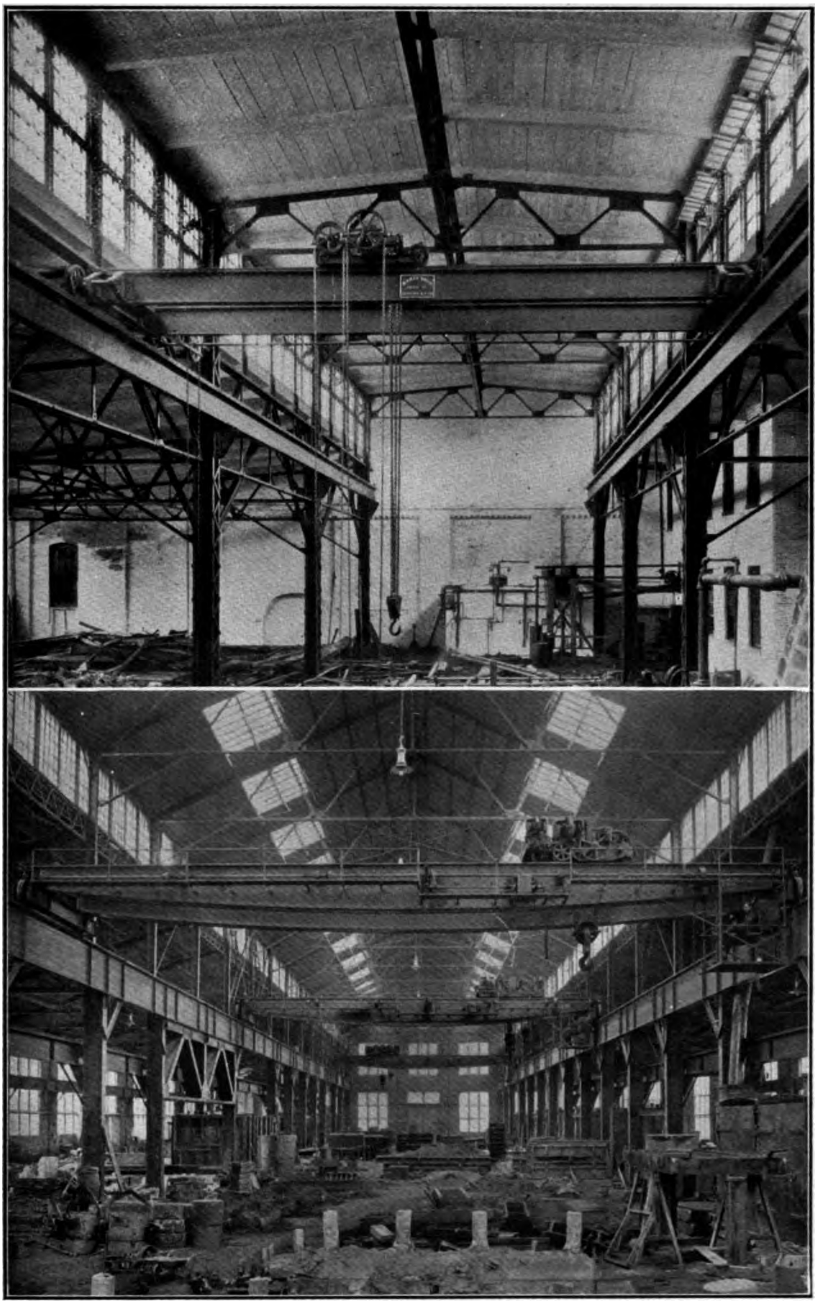
On the question of fans and blowers for the air-supply of the cupola little can be said. The devices in use are very efficient, and as engineering talent is becoming more and more available in the foundry, old notions on the transmission question are yielding somewhat to the necessities of power centralization and the benefits of a sufficient reservoir space in the blast pipe.



MOTOR-DRIVEN CUPOLA BLOWER OUTFIT, B. F. STURTEVANT CO., HYDE PARK FOUNDRY.

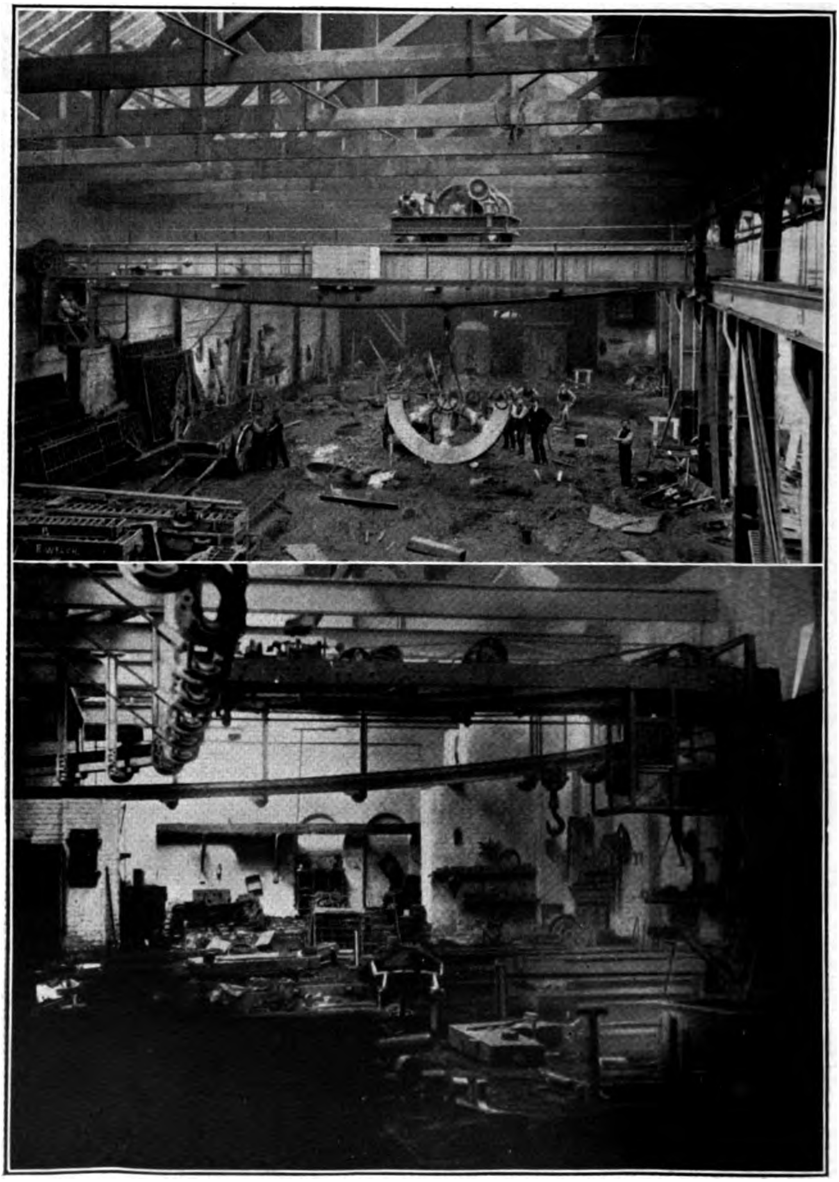
Among the least noticed, but most effective, labor-saving devices are the little things which go far to save time and work on the moulding floor. These are the shop rigs and tools, so-called, and are usually the creation of the foreman in charge, being adapted to the special needs of the patterns in hand at the time. Thus we have iron flasks shaped to hold the minimum amount of sand for the job, and yet so arranged that in closing up or turning over if required, nothing can go amiss. The variety of lifting tackle for transporting copes, handling heavy castings, and the like, is quite astonishing, as one can see after going through foundry after foundry.

Foundrymen will do well to send out their foremen and superintendents once in a while on a tour of inspection, and to conventions



CRANE SERVICE FOR THE FOUNDRY. OVERHEAD TRAVELING CRANES.

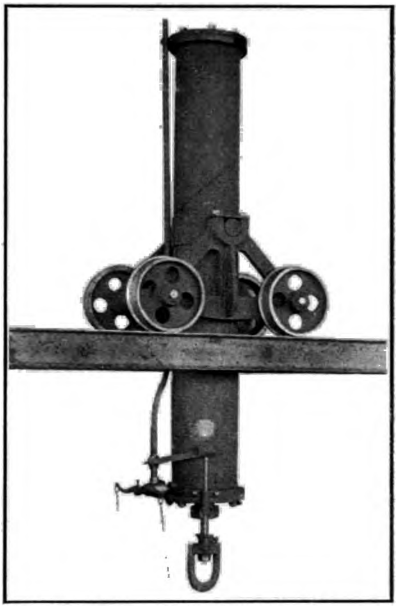
Above is shown a 27-foot span 20-foot lift 5-ton capacity crane installed by Maris Brothers, Philadelphia, for the Phosphor-Bronze Smelting Co. Below is the crane equipment in the chilled-roll foundry of the United Engineering & Foundry Co., Pittsburg, built by the Shaw Electric Crane Co., Muskegon, Mich.



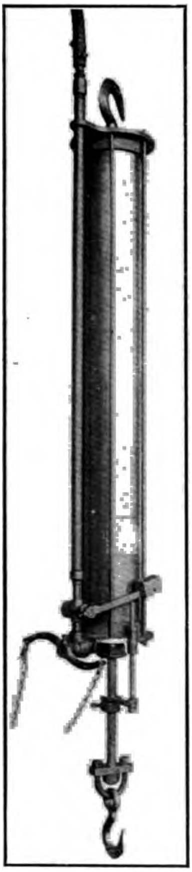
CRANE SERVICE FOR THE FOUNDRY.

Above is a 30-ton four-motor overhead travelling crane of 55-feet span, with **5-ton auxiliary**, built by Thomas Broadbent & Sons, Ltd., Huddersfield, for Fairbairn, **Lawson, Combe**, **Barbour, Ltd.**, Belfast. Below is an 8-ton single-motor overhead **crane of** 22-feet span, built by the same firm for **John Jardine, Nottingham.**

of educational value. The bright man who is "right in it" himself will pick up many a pointer which more than repays the firm for the time and expense of his trip, not to speak of the friendly feeling created between establishments where such reciprocal visits are arranged for.



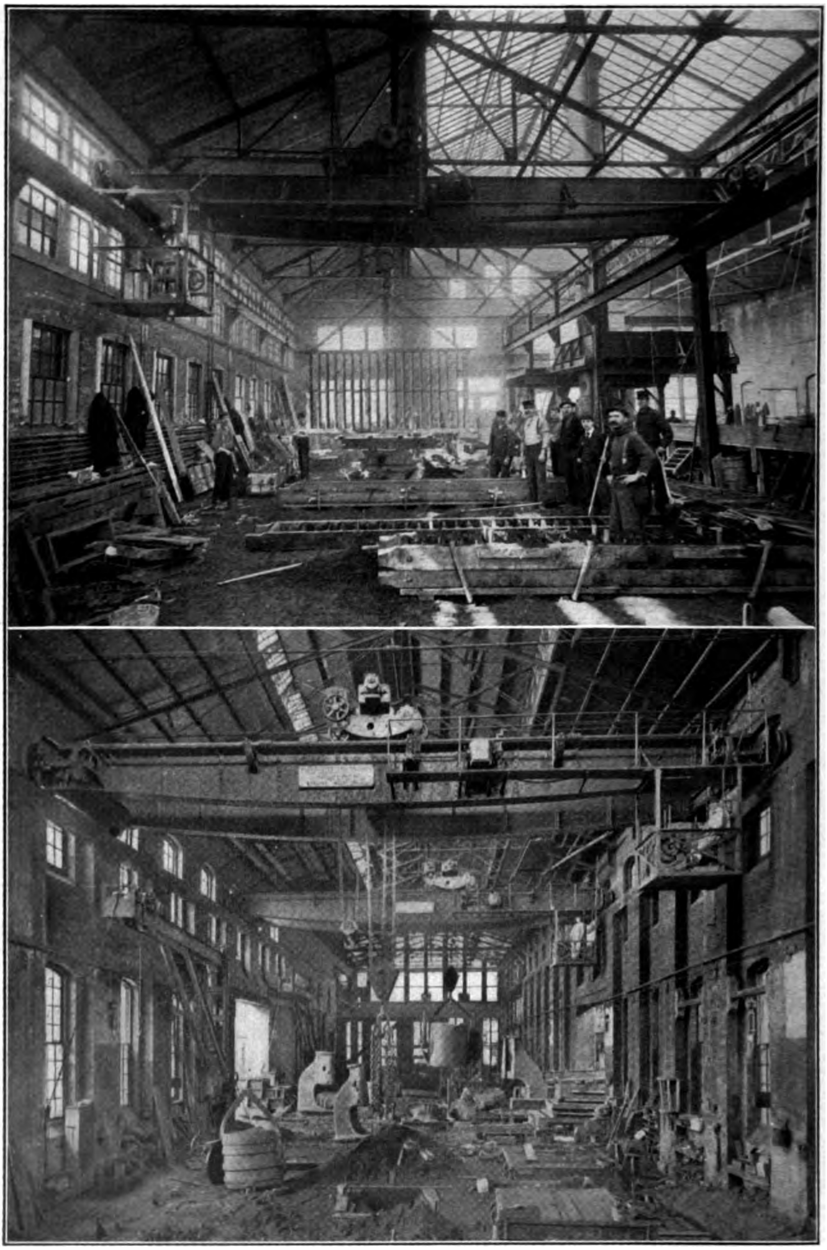
AIR HOIST WITH TROLLEY CARRIAGE.
Pedrick & Ayer Co.



AIR HOIST.
Pedrick & Ayer Co.

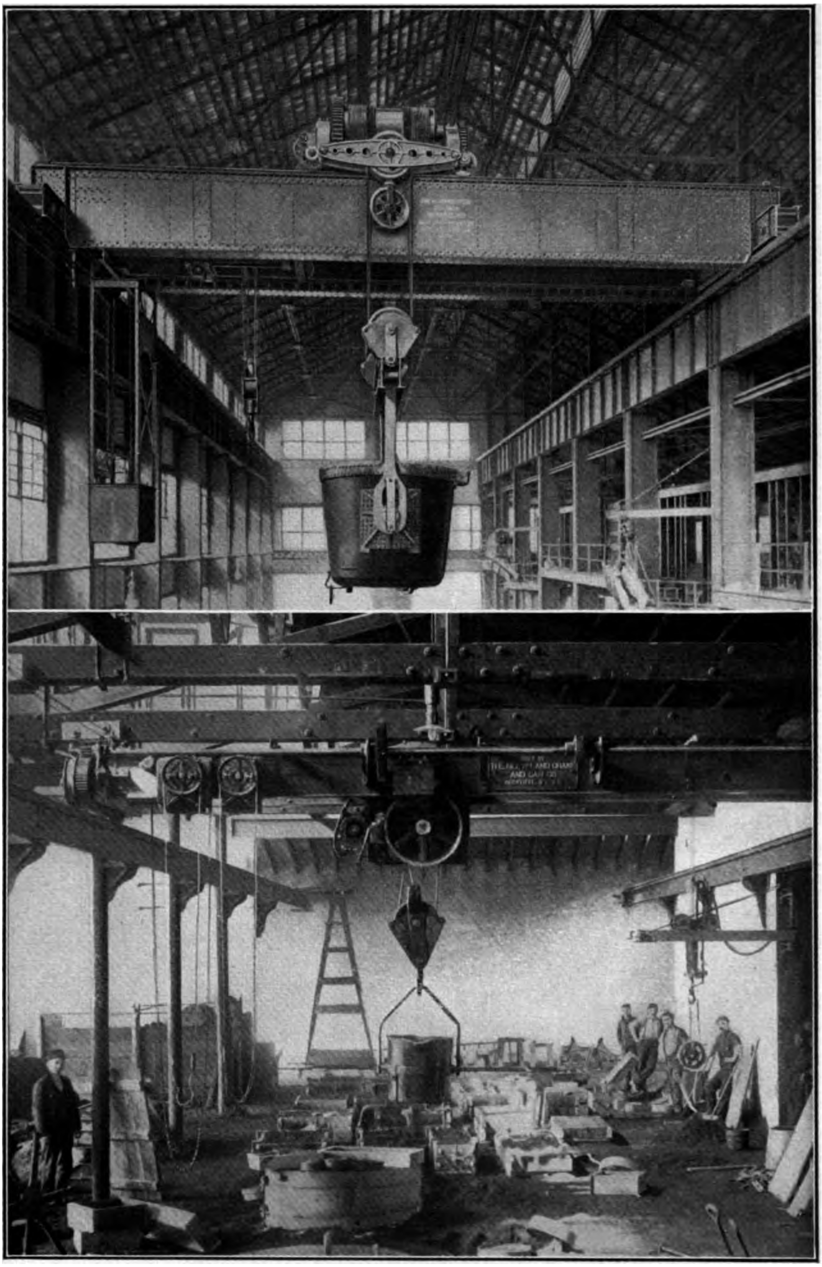
A glance through the catalogues of the foundry-supply houses shows a steadily gaining list of appliances calculated to save labor. Snap flasks may now be gotten for many and variously shaped classes of work, and the pattern shop can also show a series of tools and specialties which cut down the hard and time-consuming labor very considerably.

Under the head of transportation in the foundry proper may be included the various types of cranes. The slow and cumbersome jib cranes, still seen very plentifully in slow and conservative foundries, are gradually being replaced by power cranes of whatever type the shop requirements make necessary. The tendency today in the new shops is in the direction of the electric traveling crane, which covers the entire floor space. Cranes run by other systems of power transmission also have their application, though the flexibility of the electric transmission system gives this the preference. Smaller jib cranes, when their use becomes desirable in connection with the travelers, are either located along the side walls, or are of the portable type, taken from column to column where wanted, and there hung in position. In the older remodeled



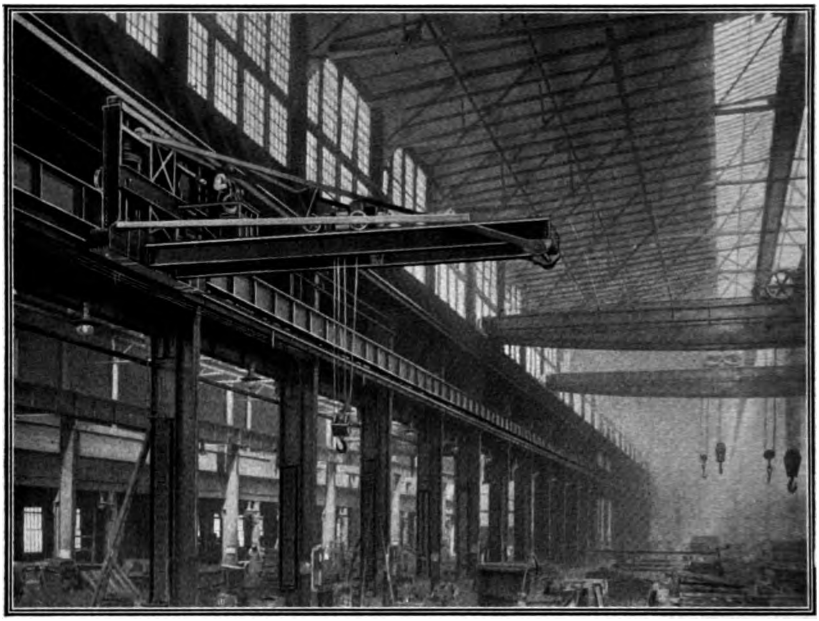
CRANE SERVICE FOR THE FOUNDRY.

Above is shown a 5-ton three-motor electric traveling crane built by the Cleveland Crane & Car Co. for the W. S. Tyler Company, Cleveland. Below is a 25-ton 48-foot span crane with 5-ton auxiliary hoist, built by the Niles-Bement-Pond Co. for the steam-hammer department of Bement, Miles & Co., Philadelphia.



CRANE SERVICE FOR THE FOUNDRY. OVERHEAD CARRIAGE OF MELTED METAL.

Above is a 75-ton ladle crane, with 25-ton auxiliary trolley, installed by Pawling & Harnischfeger in the open-hearth steel foundry of the Grand Crossing Tack Co. Below is a 10-ton two-motor crane for small overhead clearance, built for the Erie Engine Works by the Cleveland Crane and Car Co.



FIVE-TON TRAVELING WALL CRANE, FOUNDRY OF THE ALLIS-CHALMERS CO., WEST ALLIS, WIS.

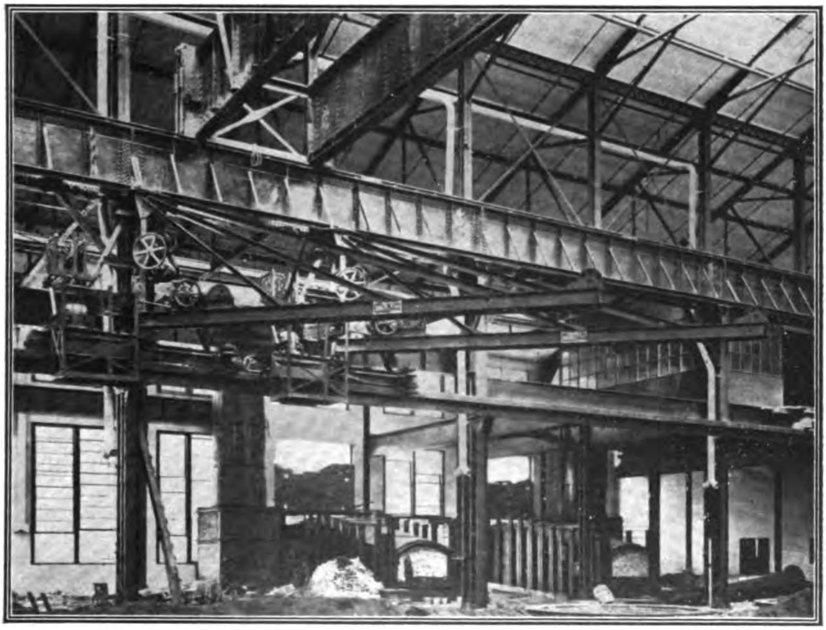
Being on a separate run-way from the standard overhead traveler, this type permits independent auxiliary service. By Pawling & Harnischfeger, Milwaukee.

foundries, where the structural work for the crane run-ways cannot be put up, powerful steam-actuated jib cranes are advantageous, though requiring somewhat of a localization of the heavier work about them.

As the cranes are required to handle everything about the foundry, from carrying in the sand to taking out the castings, it will be seen that a very busy place will require two travelers, each supplied with two hoisting bridges. Thus four hooks are available at one time, if wanted, and the getting out of work is facilitated wonderfully. On all crane systems there can be attached a pneumatic hoist wherever a quick and yet even lift is wanted. These air hoists are very handy, and are now much seen in shops where moulds are carried overhead, instead of the iron being carried to fill them.

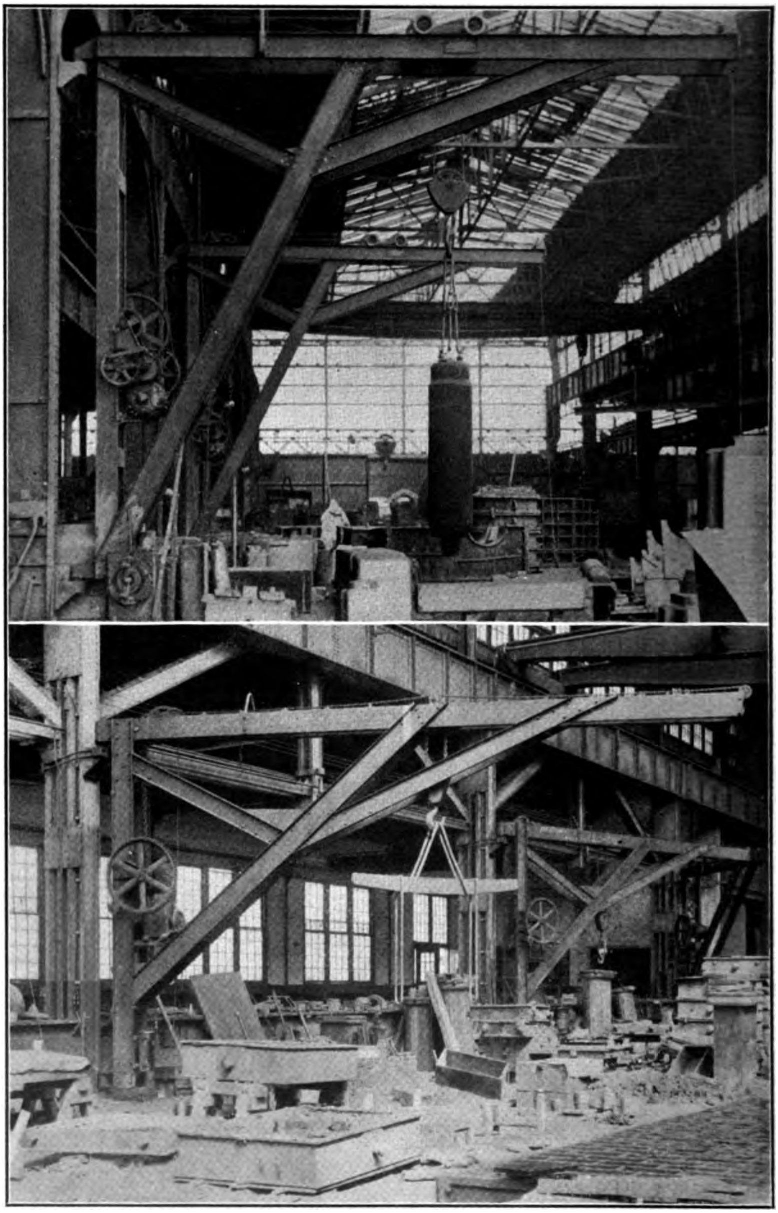
The ideal method of carrying melted metal is from overhead. Occasionally, however, it is necessary to supplement the traveler with a track system by means of which buggies, filled with the metal, can be taken out of the shop into additions not covered by the crane system. Then again the cupolas may not be within reach of the crane, and the iron must first be brought within its range. Where the installation of a traveling crane is not possible, or in fact where the work is light and the floors cover much space, the overhead-track system is highly advantageous, the men taking off the iron from the cupola spout in suspended ladles holding four or five times the amount four men could carry in shanks. Systems of this kind have proved great labor savers.

Should we wander through the core room we would occasionally find a new device for automatically clamping the core boxes together for filling, thus doubling the output of the operative. Specially constructed drying plates for intricate cores reduce their loss, and the losses incurred through castings which have to be scrapped. Well designed ovens allow a continuous replacing of the baked material by fresh lots, without interfering with the process in the least. Only on the question of core machines for green sand and regulation cores of more intricate construction have we nothing satisfactory in the market. Here is a chance for the inventor with foundry knowledge, for the countless varieties of castings which could be reduced in cost by a moulding machine making green-sand cores ready to drop into



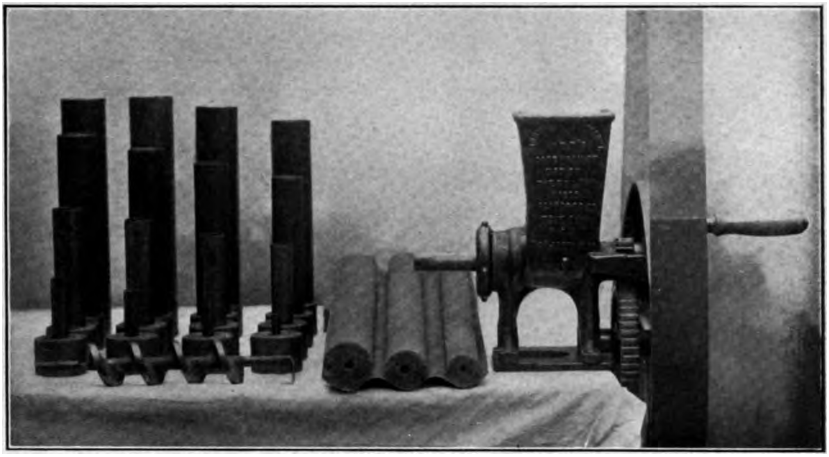
TRAVELING JIB CRANES, TRAFFORD CITY FOUNDRIES OF THE WESTINGHOUSE.

Wm. Sellers & Co., Philadelphia.



CRANE SERVICE FOR THE FOUNDRY. AUXILIARY AND JIB CRANES.

Above is an electric auxiliary jib crane, transferable type for light work, installed by the Northern Engineering Works of Detroit in the works of the Buffalo Foundry Co. Below is a crane of similar type, by Alfred Box & Co., Philadelphia, in the new foundry of the General Electric Co., Schenectady, N. Y.

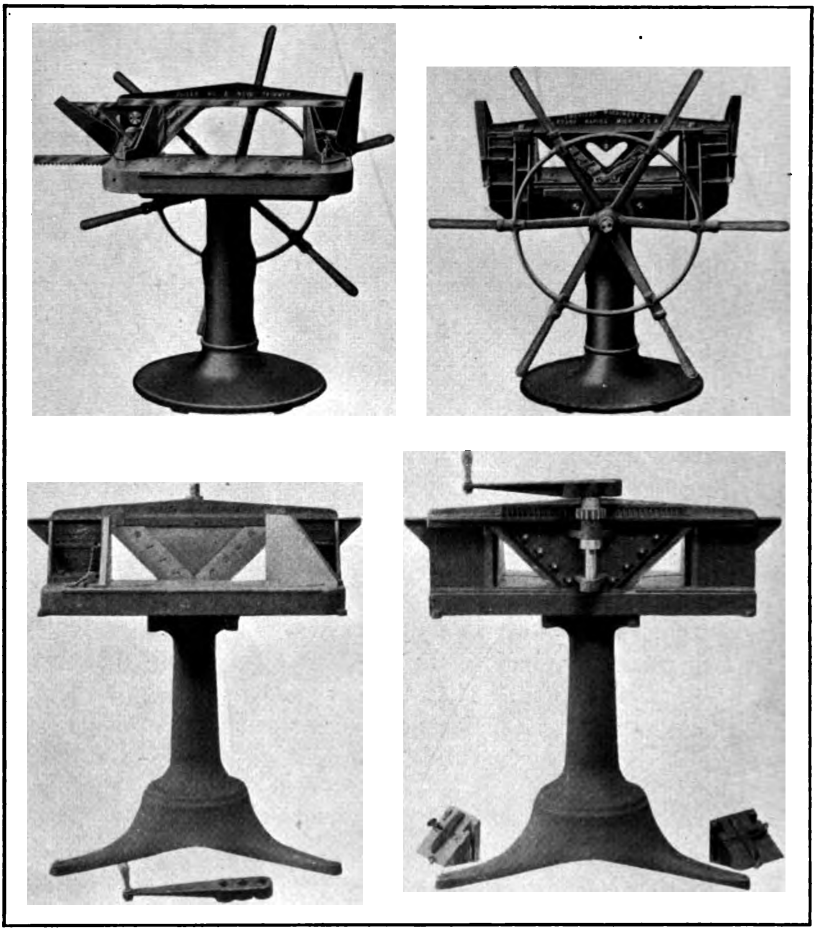


CORE MACHINE, FOR ROUND, HEXAGON, OR OVAL CORES, VENTED.
Railway Speed Recorder Co., Kent, Ohio.

their moulds, and thus replace the expensive baked article, would make such a machine a rapid seller. For the so-called stock cores which are now to be found in every foundry doing a jobbing business, machines are now on the market making a far better grade than ever came from hand work, and they turn out any diameter and length, properly vented. These stock cores are a great labor-saving institution, as a pattern maker need no longer be called in to make a lot of core boxes of various sizes for a casting, the blue print of which shows that a series of bolt holes are to be cored out. The moulder simply breaks off enough of the stock core to insert into the space left by the prints on the pattern, and the matter ends there.

In the subsequent handling of the castings, after leaving the sand, we run across a variety of labor-saving appliances. In large foundries, especially those producing brass and bronze castings, we find gate cutters, and even band saws for cutting off the runners and sprues. The steel foundry goes even further and utilizes the cold saw for this work, formerly so very laborious when handled with hammer and chisel. For taking off fins and irregularities on the face of a casting the pneumatic chipping tool is doing wonders in the way of quick work. The emery wheel also is now applied not only to stationary grinding work, but by means of the flexible shaft it may be carried about the trimming room for touching up surfaces where needed.

Taken all in all, the foundry has but few problems which have not been studied with a view of replacing hand work by labor-saving



OLIVER WOOD TRIMMERS, FOR THE FOUNDRY PATTERN SHOP.
Manufactured by the American Machinery Co., Grand Rapids, Mich.

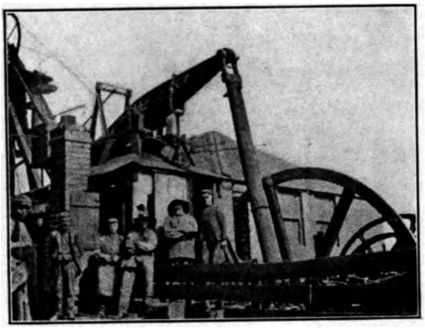
devices. Yet in few foundries do we see many of them applied. In a manufacturing establishment the foundry is usually voted a necessary evil, and oftentimes we hear the accountants declare that the plant could buy the castings cheaper outside, were it not for the difficulty of getting prompt deliveries. When considered from the standpoint of the "union" shop, with the "shop committee" in cahoots with the foreman, or terrorizing him; the superintendent knowing very little of the art of making castings; the moulders putting up their self-constituted day's work by two o'clock in the afternoon, and loafing about thereafter—the opinion above expressed is certainly correct.

THE DEVELOPEMENT OF POWER-DRIVEN MACHINERY IN THE MINE.

9

By E. H. Roberton.

The mine is of particular interest in relation to labour-saving methods, because it was the cradle of the steam engine. Indeed, some of the early inventors seem to have thought of no use for steam power except in the pumping of mines. Now the range of useful and economical mining machinery is so vast that only its outline can be sketched and typical examples illustrated. Mr. Roberton gives a condensed survey of the field and the principal directions of progress in the use of power machines in mining.—THE EDITORS.



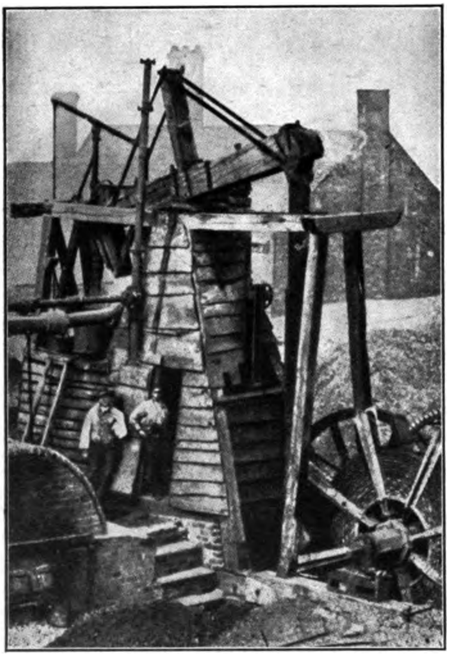
NEWCOMEN WINDING ENGINE, FARME COLLIERY, RUTHERGLEN. ERECTED 1810; STILL WORKING.

TO the mining engineer, the study of the developement of mining machinery and its influence on the conditions of the mine worker has been always full of absorbing interest. To look back on the days when our predecessors worked often in total darkness, and in daily hazard of their lives, is to admire the untiring ingenuity with which the difficulties then experienced have been one by one surmounted and left behind. The mineral was entirely worked by hand, the pick and wedge being the principal tools used; sledges were used to convey the loaded baskets to the shaft, for rails were not then thought of; the mineral was carried up the shaft by means of ladders or perhaps a hand winch, or later by a horse whim or gin; ventilation was entirely neglected, with the result that only a very few acres could be worked from one shaft, owing to the foul and stagnant air existing in the workings. Such were the conditions under which the operations connected with the extraction of mineral from the earth were laboriously carried out, before the introduction of mechanical power into the various details of mining was attempted.

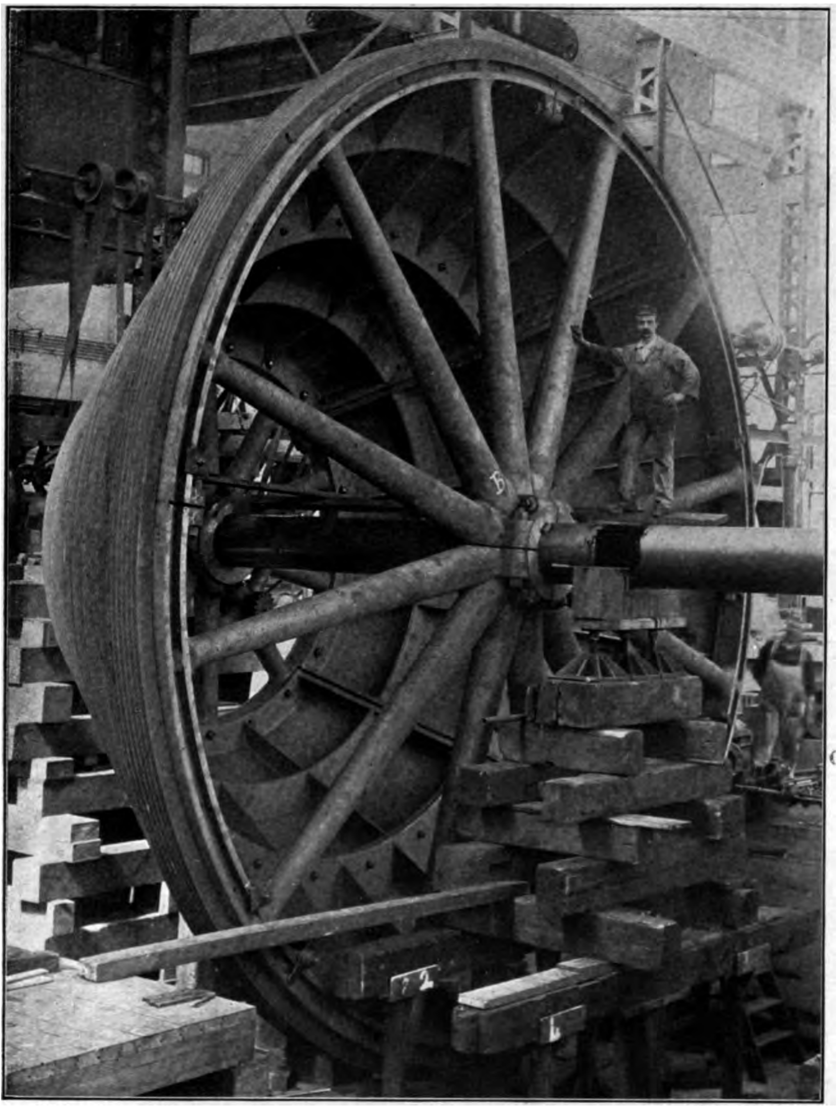
The attention of the mining engineer was first turned towards labour-saving machinery by the necessity of finding a solution of the water difficulty. In earlier days pumping was eliminated as much as

GIRL "HURRYING" COAL WITH STRAP AND CHAIN.
From the report of the Royal Commission, 1842.

possible by the use of natural drainage, a tunnel or adit being driven from the hill-side into the workings to enable the water to run out into the valley. This method was used for centuries, until at length the exhaustion of the surface deposits made the need felt for some means of draining workings that penetrated below the lowest level of the valley. Various devices were used, such as winding the water in buckets, or pumping by horse or water power, but these apparently only staved off the evil day. This point is the landmark in the history of mining at which steam appears, the first practical steam pumping engine being Savery's, invented in the year 1698. A small working model of this engine was shewn before the Royal Society on June 14, 1699, by Captain Savery, who called it the "Miner's Friend." Its action was precisely similar to that of the modern pulsometer, excepting that the valves were worked by hand. The pump consisted of two compartments alternately filled with water by suction, and emptied by the pressure of steam acting directly on the surface of the water, and was said to be capable of raising water two feet for every pound pressure in the boiler. This and



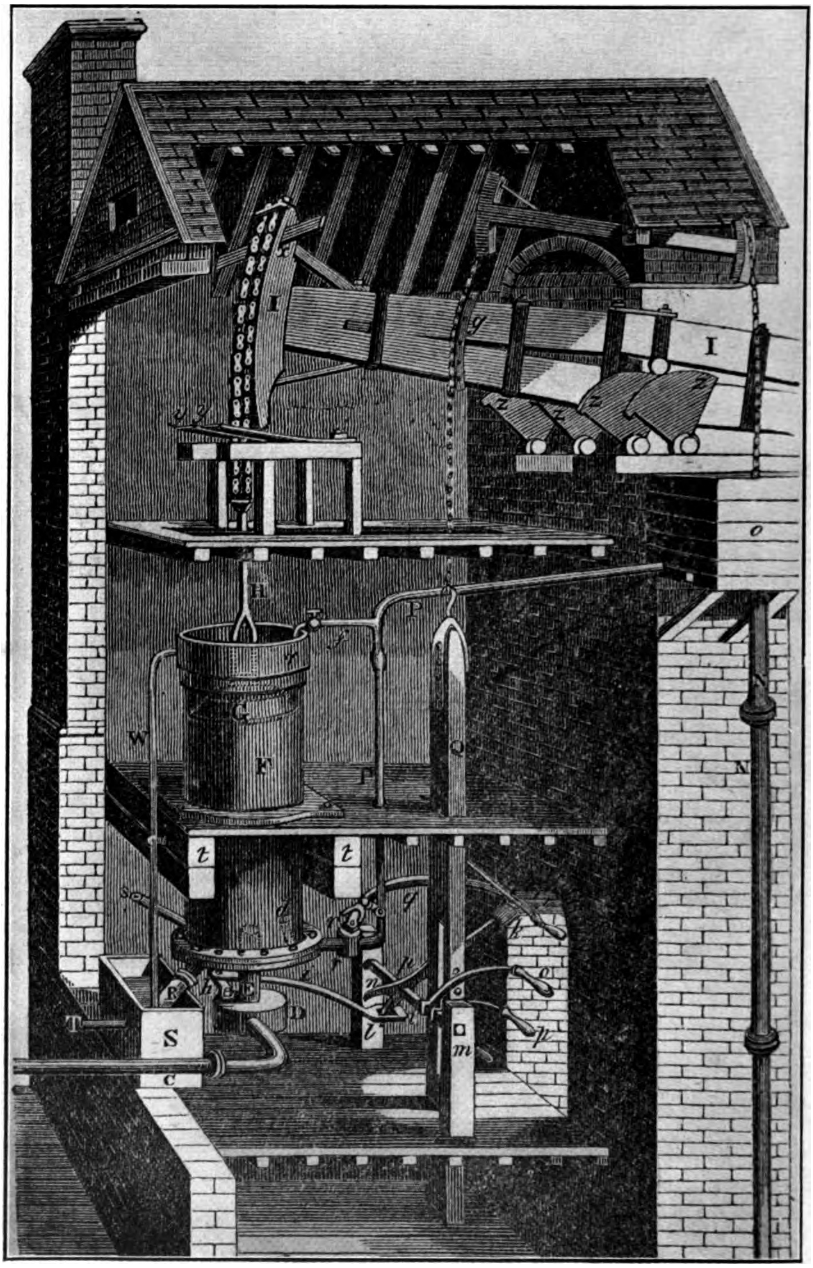
COLLIERY WINDING ENGINE, COALBROOKDALE, MADE ABOUT 1790.
From Mr. Henry Davey's paper before the Institution of Mechanical Engineers.



HALF OF A MODERN CONICAL WINDING DRUM, SHOWING THE INTERIOR FLANGES. Size 25 feet 5 inches by 12 feet. Built by the Allis-Chalmers Company for the Atlantic Mining Company.

some other early forms of the steam engine are shown on the following pages.

The first piston engine to be used was built by Newcomen and Cawley, and worked at a mine near Wolverhampton. Improvements

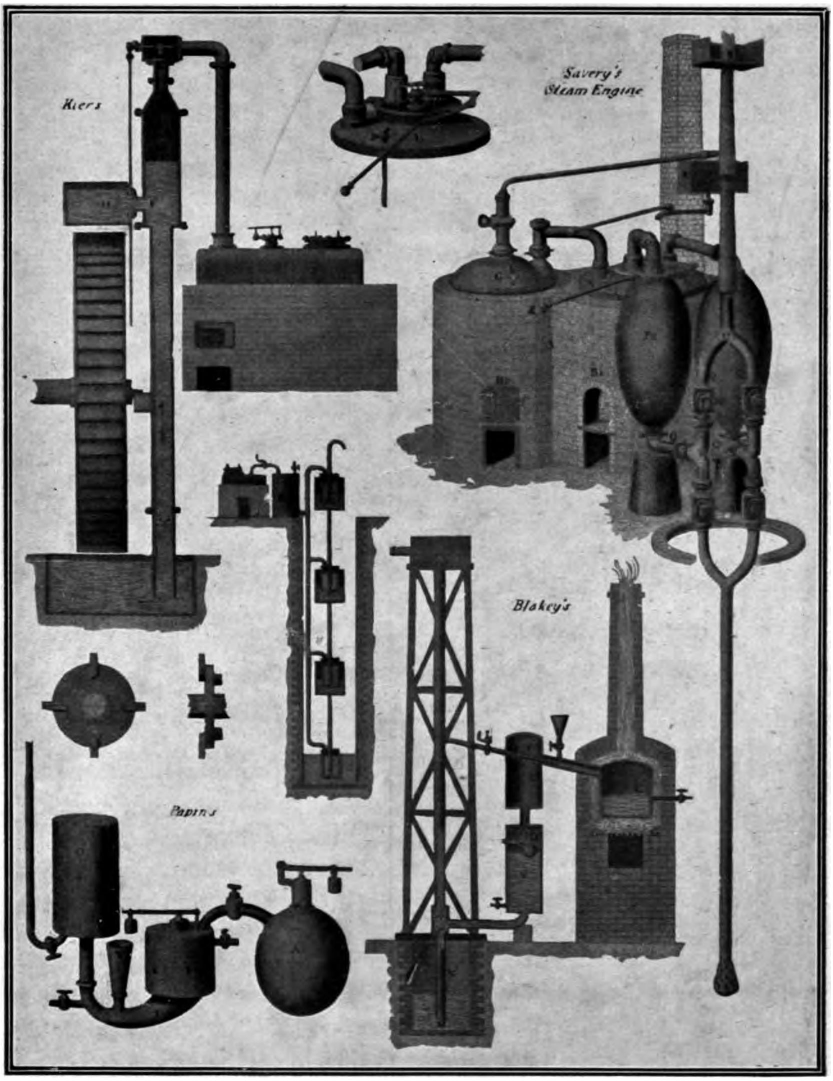


THE NEWCOMEN PUMPING ENGINE. FROM GALLOWAY'S "HISTORY AND PROGRESS OF THE STEAM ENGINE," 1827.

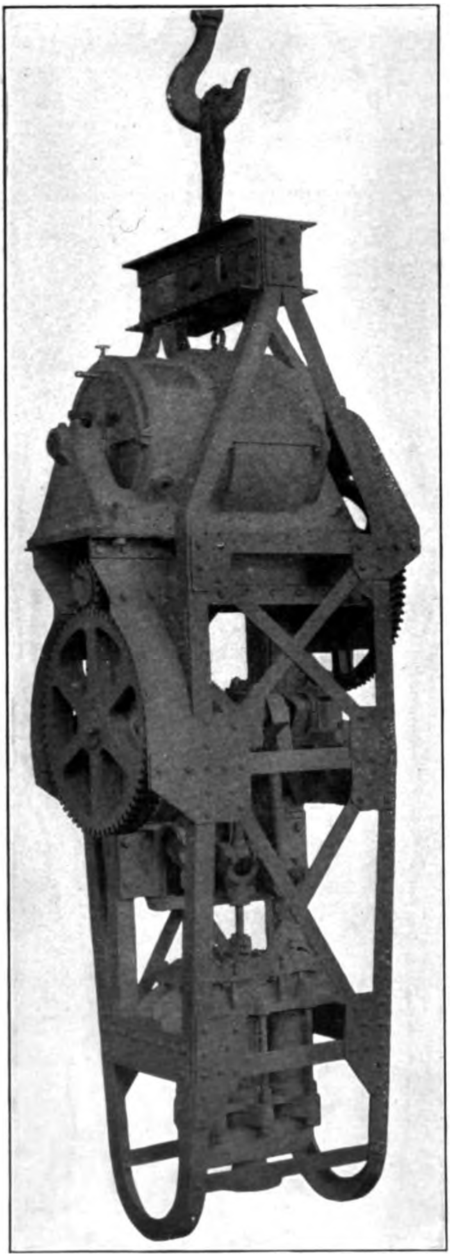
This represents the "atmospheric" engine as improved by Smeaton, and shows the advance which had been made along this line at about the time Watt was engaged on his independent investigations.

in this type of engine were introduced by Smeaton, Watts, and Woolf. Thus was evolved the Cornish pumping engine, which is still in great favour with mining engineers, being especially useful where there is an excessive quantity of water to be dealt with.

Since the introduction of the Cornish engine there have been many newer types of pumping engine placed on the market, devised mainly



SOME OF THE EARLIEST FORMS OF THE STEAM ENGINE APPLIED TO MINING.



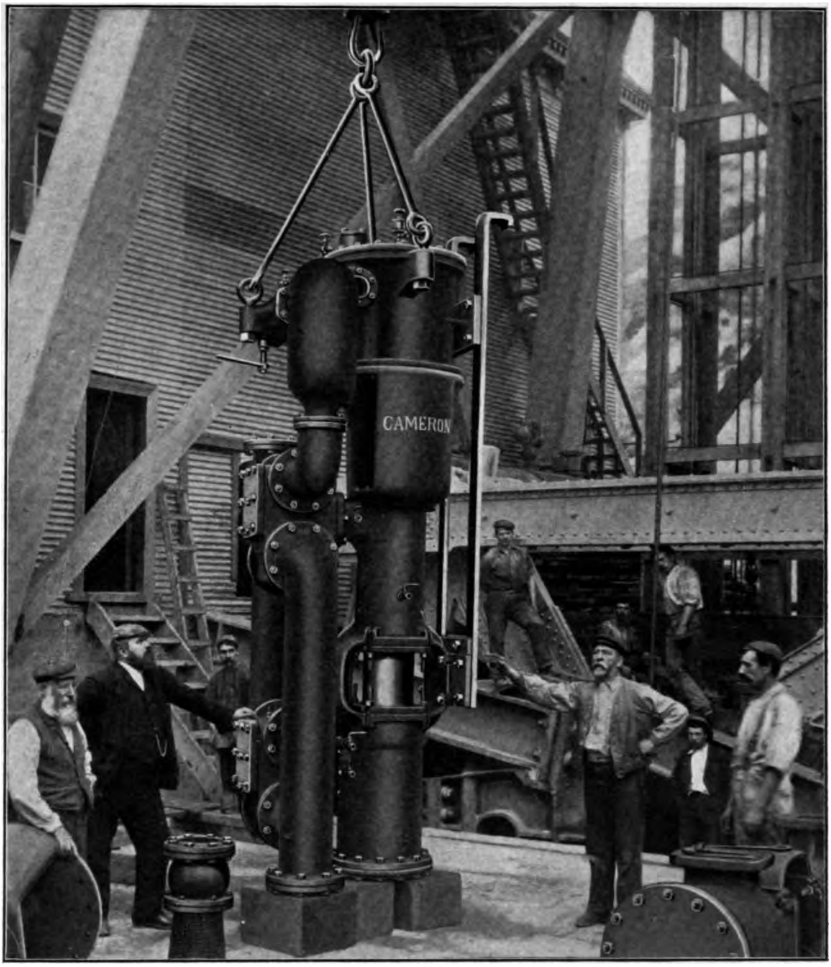
ELECTRICALLY DRIVEN SINKING PUMP.

Easton, Anderson & Coolden, Ltd.

with a view to greater working economy, or designed for some special purpose. For instance, in the operation of sinking, large feeders of water are often met with, and as this is often very gritty, special forms of pumps have been devised to raise it to the surface. These are designed with a view to great portability, and suitability for working suspended in a confined space, and also for the discharge of a large quantity of water relatively to the size of the pump.

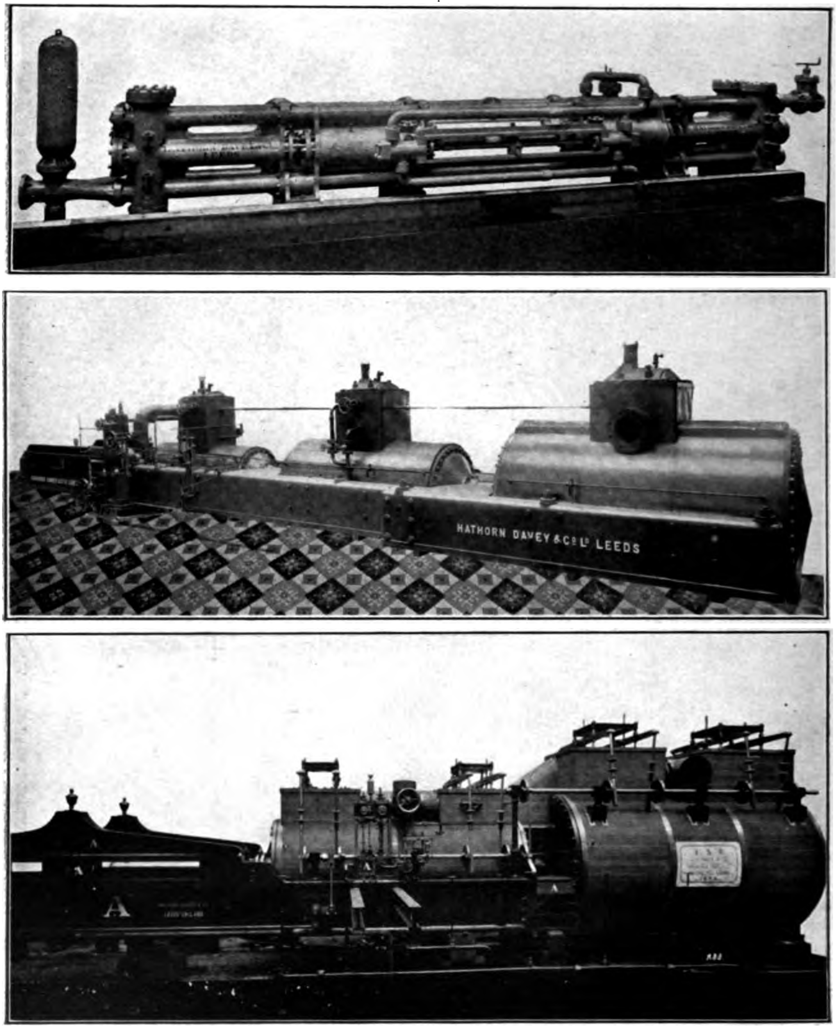
In the case of a mine which does not give out an excessive amount of water, that type of pump is preferable which is situated at the bottom of the shaft and derives its power from steam led down the shaft. Electricity can be used, and in many mines this is the power transmitted, but for large pumps steam is preferable unless the use of steam pipes is undesirable owing to the position of the pumps.

It is probable however that for raising the water from sinking shafts electricity will supersede steam, owing to its eminent adaptability for the rapid raising and lowering of the pump, without the disadvantage of leakage of power through defective



CAMERON VERTICAL SINKING PUMPS FOR THAMES HAURAKI GOLDFIELDS, LTD., NEW ZEALAND. CAPACITY, 1,500,000 GALLONS A DAY.

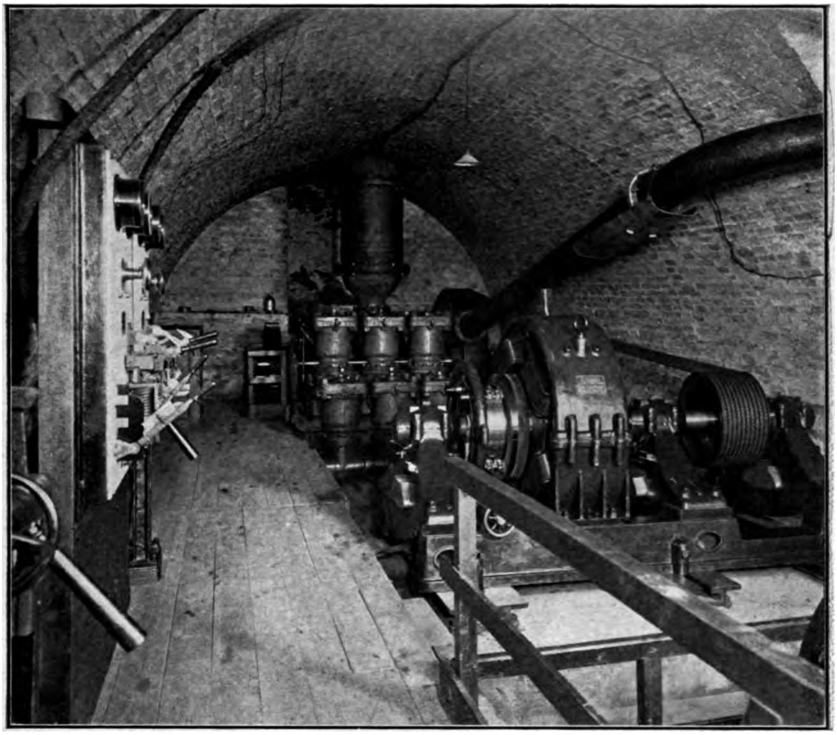
steam joints. For working pumps, too, near the face, and at a distance from the shaft, electricity is admirably suited. It has always been a costly process to keep the working faces dry when working to the dip. In flat and slightly undulating strata especially, the water collecting in the working face is a constant source of annoyance both to the mining engineer and to the working miner himself. The usual method of overcoming this difficulty has been either by the use of hand pumps, or pumps worked by a crank connected with the mechanical haulage. Electrically driven pumps, owing to their extreme portability, afford an



TYPES OF MINE PUMPING ENGINES.

At the top is a hydraulic pump for Loamhead Colliery, capable of forcing 300 gallons a minute from a depth of 1,000 feet. Next is a triple-expansion differential pumping engine for main-shaft pumping, 27, 40, and 66-inch cylinders, 8-feet stroke, 34-inch pumps. At the bottom is a compound differential pumping engine, South Staffordshire mine-drainage type, capable of raising 1,500 gallons a minute from a depth of 900 feet. Cylinders 45 and 76 inches, 10-feet stroke, 24-inch pumps. All are by Hathorn, Davey & Co., Ltd., Leeds.

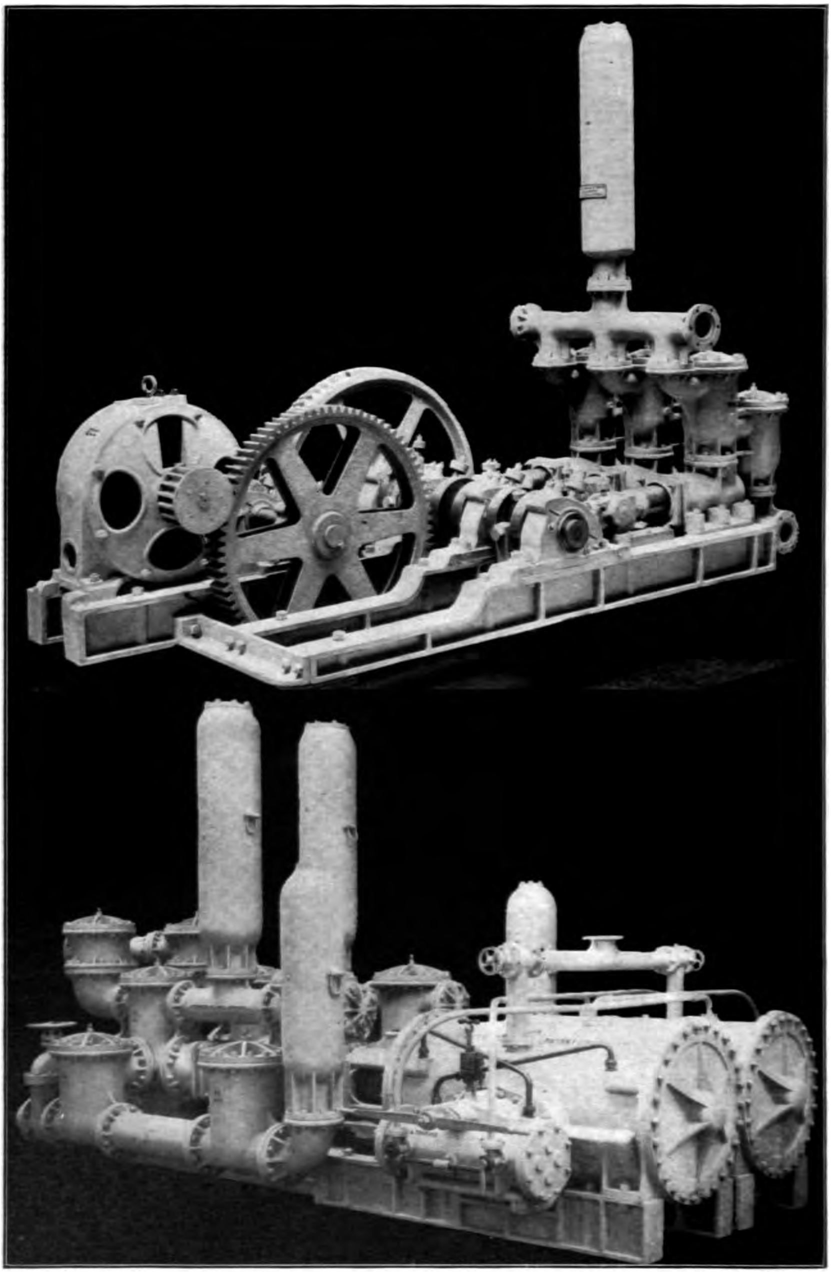
excellent solution of this problem. Occasionally hydraulic, compressed-air, or oil-engine pumps are used; the last named being as a rule unsuitable, since coal dust enters with the air into the carburettor and causes trouble.



ELECTRICALLY DRIVEN UNDERGROUND PUMP, SOUTH DURHAM COLLIERY.

Two three-throw ram pumps, 11 inches diameter and 18 inches stroke, each designed to raise 500 gallons of water 400 feet at 28 revolutions; 95 amperes, 500 volts; by Ernest Scott & Mountain, Ltd.

As the depth of mines increases, the water difficulty, in so far at least as coal or other stratified mineral is concerned, will tend to diminish, as the water does not readily penetrate through the lower strata, and after the shafts have been tubbed and made watertight there will be little water to contend with. In such mines however as proceed to depth, making at the same time large quantities of water, the problem of economical deep-mine pumping must be faced. To place the engine at the shaft bottom is out of the question, as beside the danger of the engine room being "drowned out," the sectional thickness of metal required in a deep mine for the lower portion of



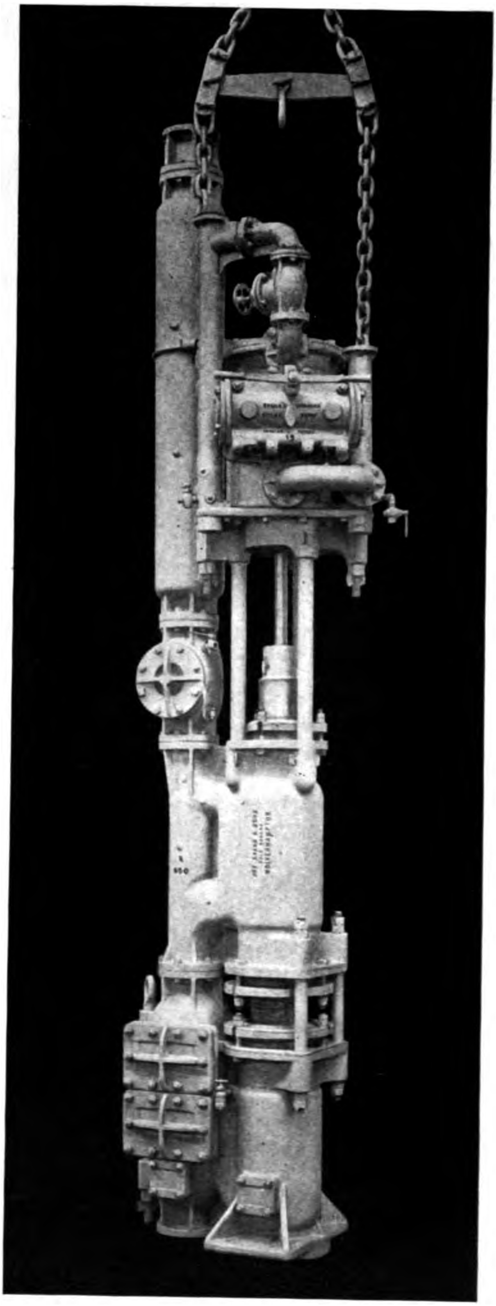
THE LOWER FIGURE IS AN "UNDERGROUND PUMPING ENGINE" AND THE UPPER FIGURE AN ELECTRICALLY DRIVEN THREE-THROW UNDERGROUND RAM PUMP.

Both by Jos. Evans & Sons, Wolverhampton.

the rising main would be excessive. On the other hand, spear rods of great length working in the shaft would prove very unwieldy, and be a possible source of weakness and danger. Probably a compromise between the two would serve best, the engine being placed in a chamber half-way down the shaft, pumping from the bottom to its own level by means of spear rods, and at the same time forcing the water from its own level to the surface.

If the miner of the present day were asked what he considered the greatest improvement in mine methods effected during the past century, he would probably point to artificial ventilation. The miner cannot perform good work where there is not good breathing air, and it is quite noticeable that in any district of a mine where for some reason or other the air becomes "slack," the output per man immediately diminishes.

In the early days of mining, in mines where ventilation was not entirely neglected, natural ventilation was deemed



EVANS SINKING PUMP.

sufficient; the difference in temperature between the internal and external atmosphere promoting a current of air through the workings. This of course was very feeble, but over the small areas then worked served the purpose of the miner fairly well. As the shafts deepened, and the area worked became more extensive, ventilation was effected by placing a fire in the "upcast" shaft, which rarefied the air in that shaft and caused it to rise, its place being taken by air passing down the "downcast" shaft, through the workings, and so to the "upcast." The furnace was at first simply slung in the shaft by chains, and drawn to the surface when it required replenishing, but later the more thorough method of placing a permanent furnace grating at the bottom of the shaft was substituted.

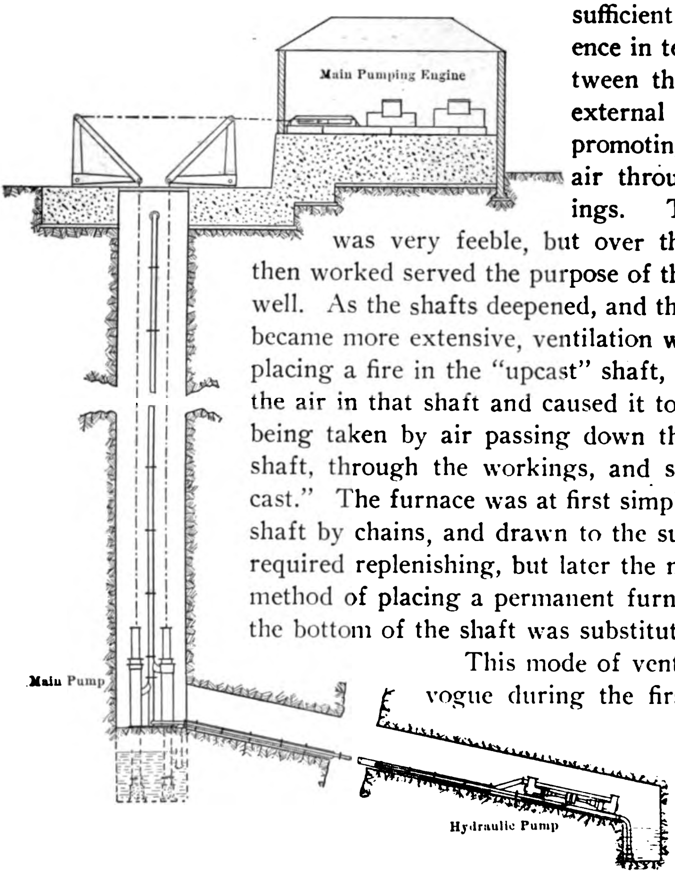


DIAGRAM SHOWING APPLICATION OF A HYDRAULIC PUMP TO DIP WORKINGS.
The pump is driven by water taken from the foot of the rising column of the main pumps.

This mode of ventilation was in vogue during the first half of the past century, and even now is made use of in many important mines. At a large colliery in the north of England, a furnace utilised in a pit drawing over 1,000 tons per diem creates a ventilating current of 100,000 cubic feet per minute, with a water gauge of 0.6 inch.

The first attempt to construct machines for mechanical ventilation resulted in the production of reciprocating contrivances, being in fact huge air pumps. These, in order to produce anything like adequate ventilation, had to be made of enormous dimensions, and were proportionately clumsy. The excessive wear and tear of the reciprocating parts and of the valves soon caused this type to be discarded, the only one obtaining any success being the Hartz blower. A rotary displacement fan, known as Root's blower, attained some success in

UNDERGROUND FURNACES FOR MINE VENTILATION.

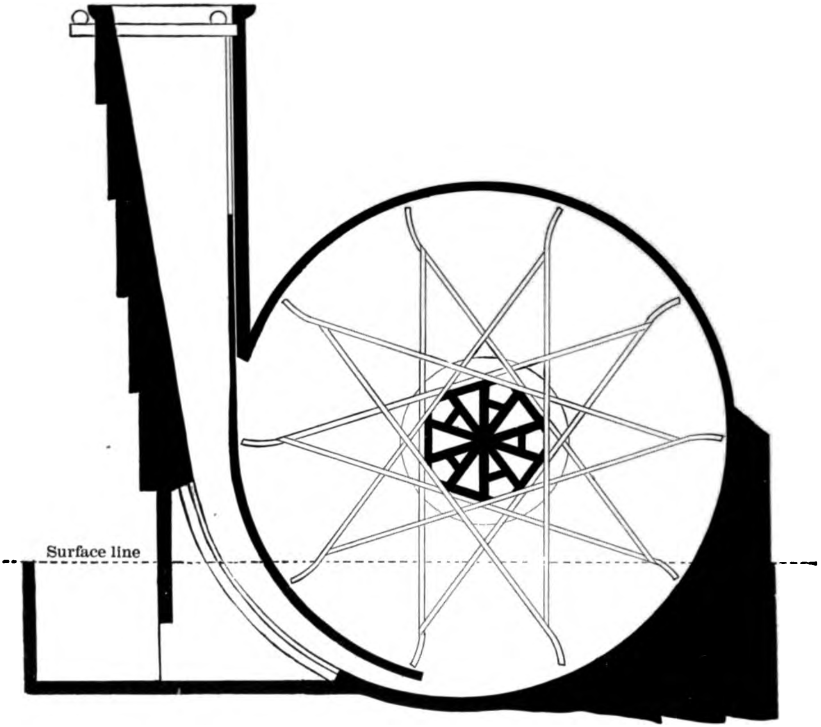
Situated at a depth of 400 feet. Each furnace is 8 by 4 feet.

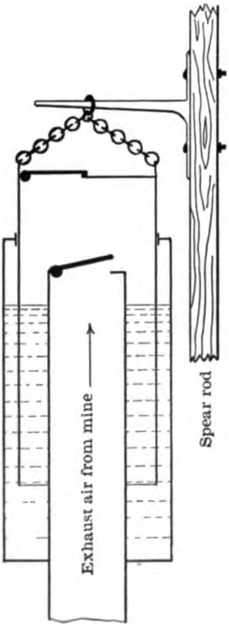
mine ventilation, but is now generally used for furnaces and smiths' fires. The type of fan which has superseded all others is the centrifugal type, and at the present day over 90 per cent of ventilating machines at work are of this type.

The consumption of air in a mine is roughly gauged by the number of men employed underground at one time, 500 cubic feet of air per minute being allowed for each man, and in the case of a gaseous pit, as many as 1,000 cubic feet per man per minute are needed. This excess is needed to dilate the harmful gases exuded from the coal, or generated by shot firing, and to supply air to the horses and ponies.

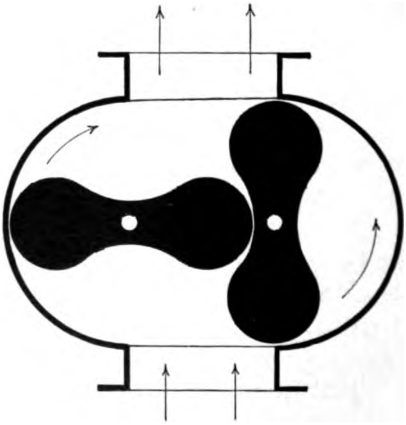
Some idea will be gained from this as to the enormous capacity and power of a modern ventilating fan, especially in view of the great lengths of galleries requiring ventilation, the friction caused by the tortuous passage of air through an extensively worked area, such as is now served by one pair of shafts, being a very considerable item.

Perhaps nothing has exercised more influence on the development of mining than the introduction of mechanical haulage. With its aid the mining engineer lays out, from one pair of shafts, workings over an extent that in the days of hand or horse haulage he would have declared impossible. So perfect is modern practice in this respect that



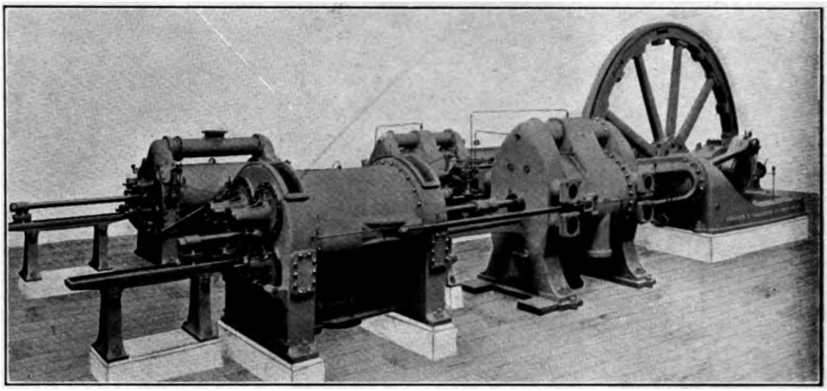


Hartz Blower



Root's Blower

MECHANICAL VENTILATING APPARATUS.
THE TOP FIGURE IS THE GUIBAL FAN.

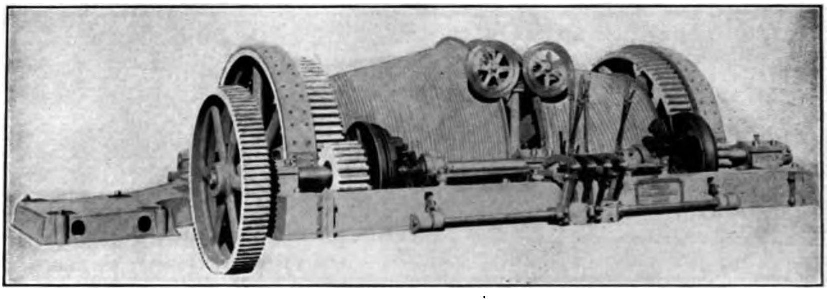


RIEDLER AIR COMPRESSOR, BUILT FOR SIMMER & JACK, EAST PROPRIETARY MINES, JOHANNESBURG.

Steam cylinders 34 and 56 inches, air cylinders 32 and 52 inches, stroke 60 inches; 8,040 cubic feet free air when running 58 revolutions; 120-pounds steam, 75-pounds air pressure; flywheel 26 feet diameter, 36 tons. Fraser & Chalmers, Ltd., London.

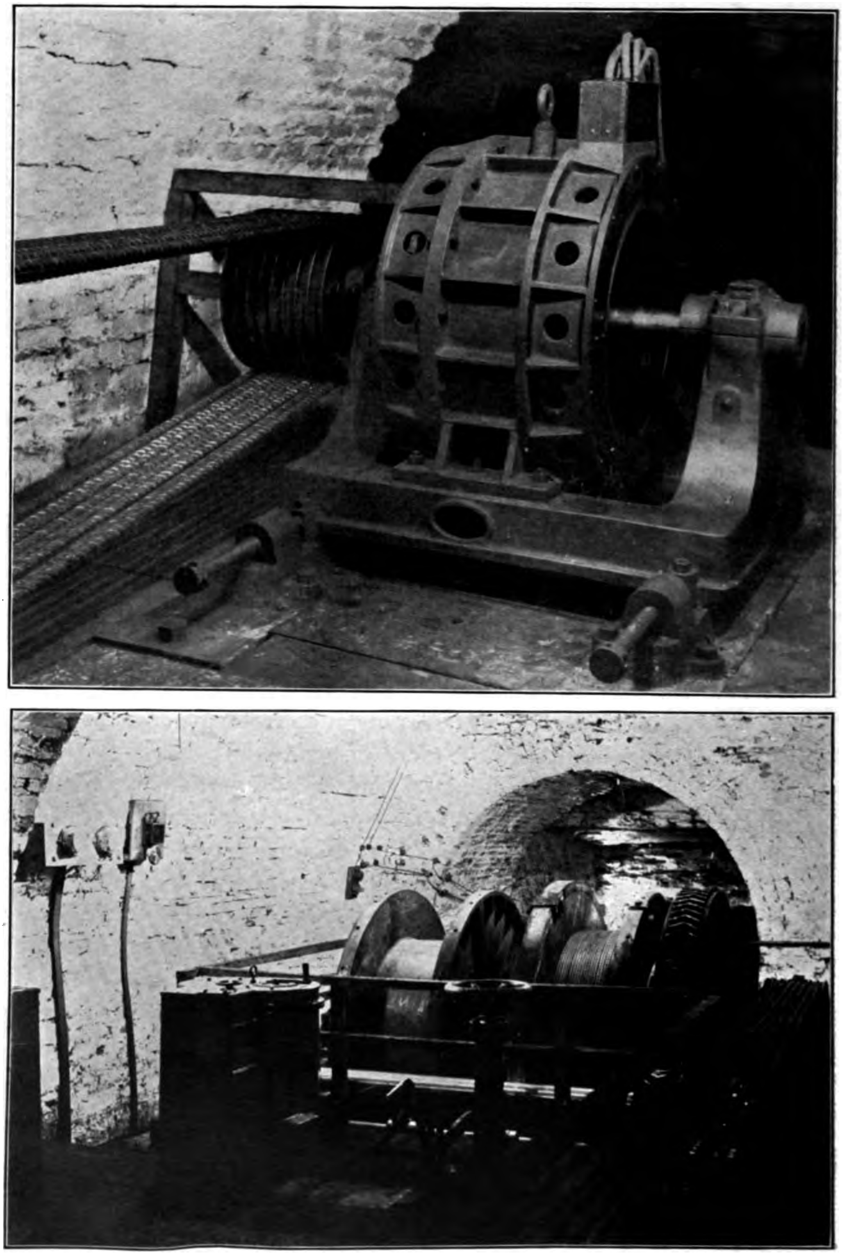
the cost of underground conveyance of material has been reduced to less than 2d. per ton per mile. The arduous labour of dragging the mineral in a sledge along the underground passages was replaced by hand haulage over wooden rails, which in turn gave way to horse-haulage over iron rails. And now over the greater part of the workings rope haulage has taken the place of hand and horse haulage, and with the introduction of electrical and compressed-air locomotives, mechanical haulage bids fair to supersede both men and animals in every large mine.

The earliest attempt at mechanical haulage was the simple contrivance by which a number of full tubs descending an incline were made to draw up a similar number of empty tubs. by means of a rope passing over a pulley at the top of the incline. The first introduction



ELECTRIC MINE HOIST WITH DOUBLE CONICAL DRUM.

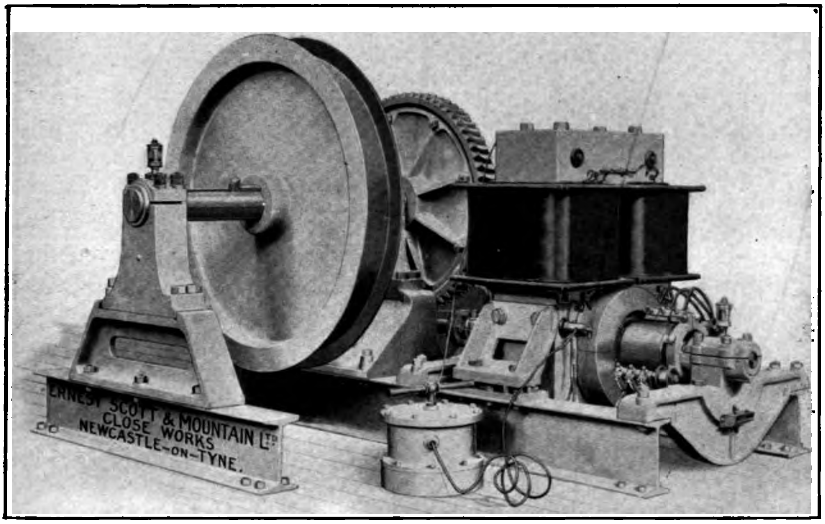
Driven by 150-horse-power direct or alternating-current motor. Denver Engineering Works, Denver, Col.



UNDERGROUND MAIN AND TAIL-ROPE ELECTRIC HAULAGE, TY TRYST COLLIERY.

50 horse-power, rope-driven from three-phase motor; speed 5 miles an hour up a gradient of 1 in 11; drums 5 feet in diameter and 2 feet wide. The upper figure shows the motor and driving end. Installed by Ernest Scott & Mountain at the Pochin Colliery of the Tredegar Iron and Coal Co., Ltd.

of power haulage was effected by an endless chain which passed in and out of the workings taking the tubs along with it. The chain soon gave way to the wire rope, which was found to be much lighter and more reliable, and is in great favour at the present day. Another very common mode of power haulage is known as main and tail-rope haulage, and consists of a "main" rope which draws a set of full tubs out of the workings, while a "tail" rope, of lighter make, attached to the end of the full set, passes round a pulley at the inbye end, and draws the empty set inbye, the empty set also pulling the other main rope in with it.



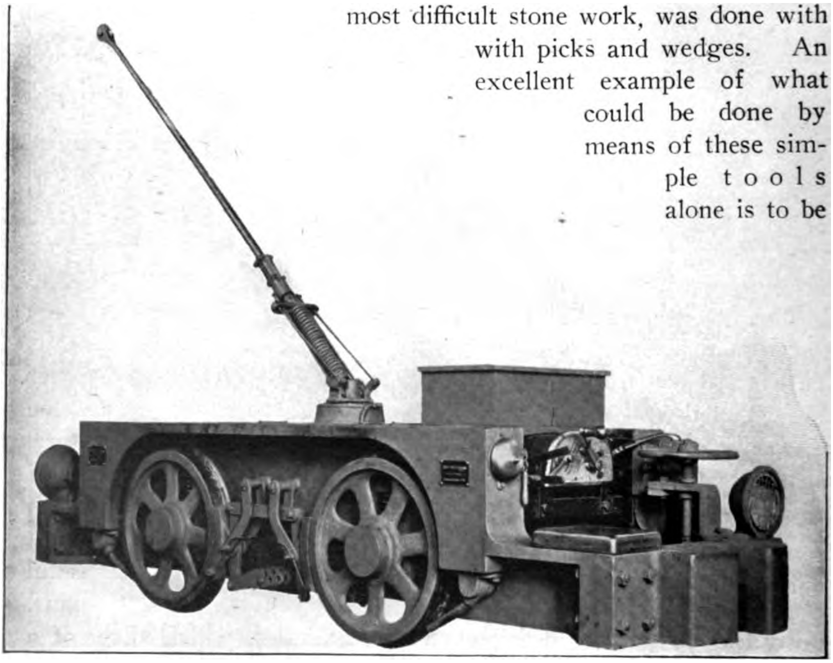
ENDLESS-ROPE HAULAGE, ELECTRICALLY DRIVEN THROUGH WORM GEAR.

The best practice in secondary haulage is to be found in some American mines, where the replacing of animals by locomotives is said to have reduced the cost of underground haulage by over 50 per cent. The drawbacks to the use of locomotives in mines are the necessity for using heavier and more carefully laid rails at the face, and the difficulty of lifting the motor on to the track in the event of its becoming derailed. The choice of power lies exclusively between compressed air and electricity, steam and oil being rejected on account of the heat and fumes generated. Compressed-air motors are useful in their cooling effect, and in adding to the ventilation of the mine. If working in large and fairly straight galleries, which allow of a capacious receiver being used on the motor, a pressure of 500 pounds is used, but if the workings are narrow and permit only of a small receiver being used, the pressure is often as high as 2,000 pounds. The useful effect of these motors is nearly doubled by heating the air before passing it into the cylinders.

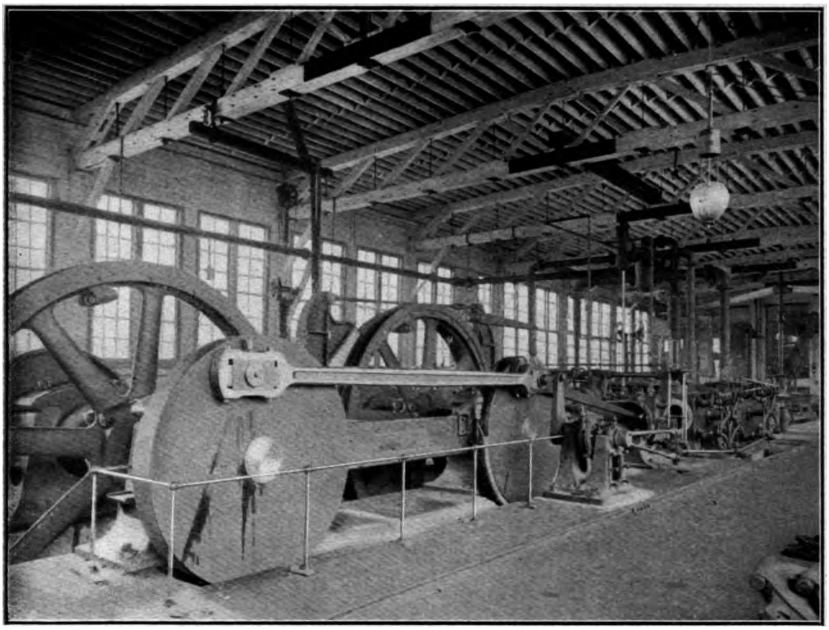
The electrical underground locomotive has been in use in America since 1889, and at the present day it is estimated there are about 700 at work. It has many advantages over the compressed-air motor, not the least being the simplicity of its construction and mode of operation. A comparison of electrical and compressed-air locomotives shews that for a given tractive power the former occupies a considerably smaller space, its length being four-fifths, and its cross section one-third that of the latter, while of course the distance over which the former can run is indefinite, the latter being limited to its air capacity.

It is probable that in the near future one of the chief factors that will make for the developement of our mining industries, especially of the coal industry, and for cheapening the cost of production, will prove to be the increasing use of labour-saving machinery in the actual working of the mineral.

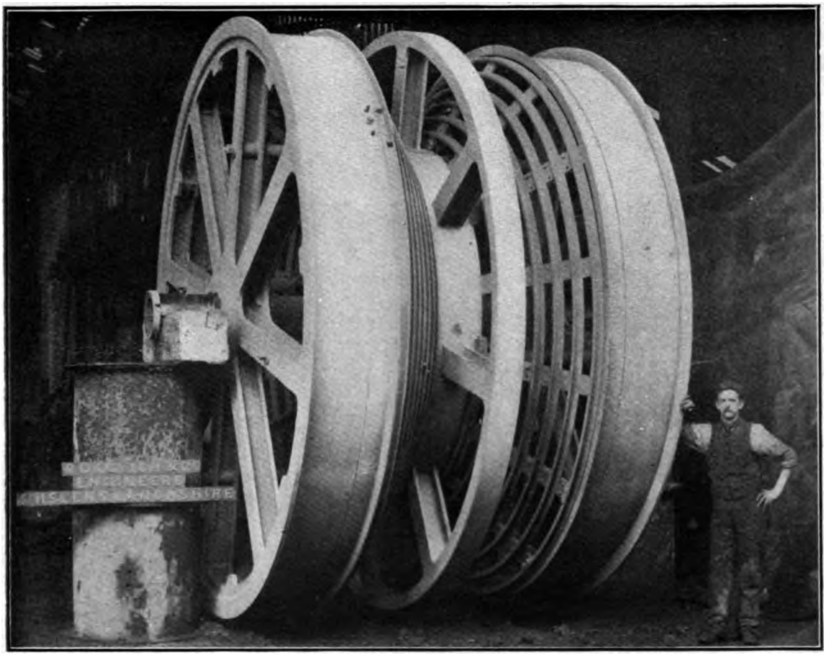
In the early days of mining, before gunpowder was thought of as an aid to the worker, all work, even the most difficult stone work, was done with with picks and wedges. An excellent example of what could be done by means of these simple tools alone is to be



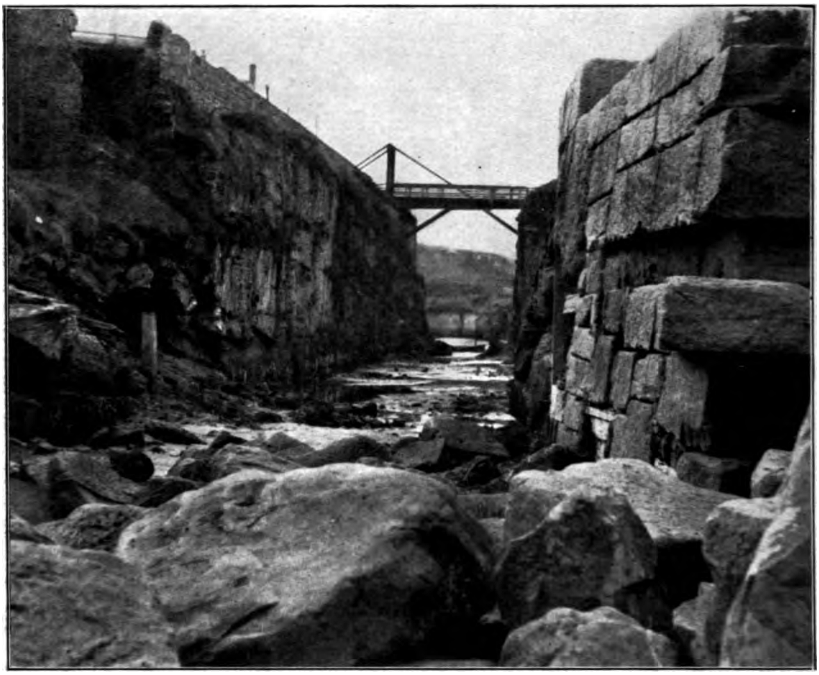
ELECTRIC MINING LOCOMOTIVE, OF 25 HORSE POWER.
Ernest Scott & Mountain, Ltd., Newcastle-on-Tyne.



A MODERN MINE HOISTING ENGINE.
Whiting hoist, as built for South Africa by the Allis-Chalmers Co., Chicago.



A PARTIALLY CONICAL (INTERNAL) AND PARTIALLY CYLINDRICAL WINDING DRUM.
R. Daglish & Co., St. Helen's, Lancs.



PASSAGE INTO SEATON SLUICE HARBOUR, NORTHUMBERLAND. CUT THROUGH THE SOLID ROCK WITHOUT THE AID OF EXPLOSIVES.

seen in Northumberland in the old harbour of Seaton Sluice, now disused, the passage into which was cut out of the solid rock without the aid of any explosive whatever.

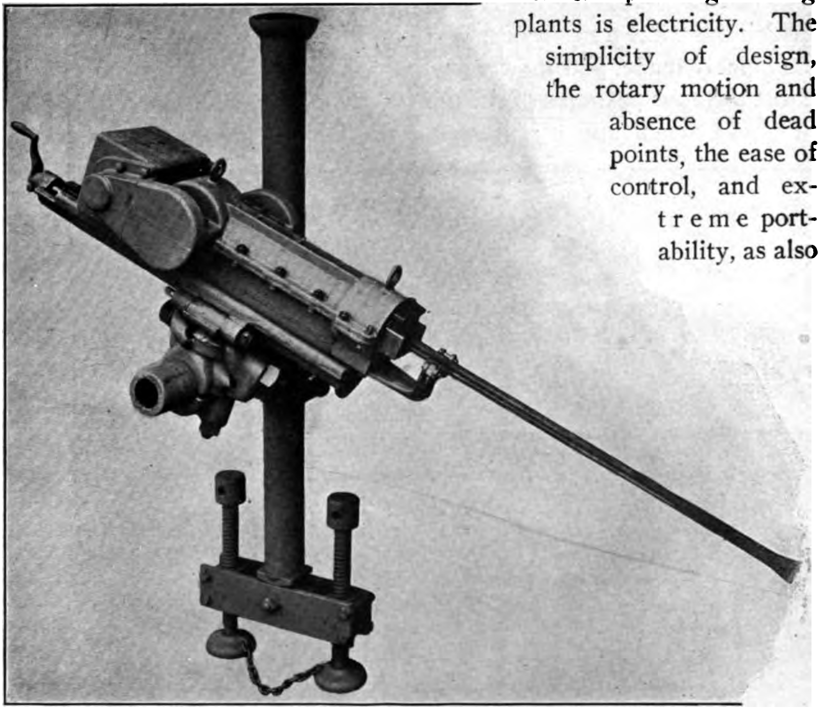
So late as the year 1810, according to a work on coal mining written about that time, the wedge and mallet were the means used to force down the coal, which was then placed on corves, or baskets made of hazel twigs, and drawn by hand, either on a sledge or upon a "train road," to the shaft. Since that time horses and machinery have replaced manual labour in the haulage roads, wedging has been entirely superseded by the use of gunpowder or other explosive, but the arduous task of "undercutting" the coal is in most collieries still performed by hand.

Drilling machines worked by power derived from electricity or compressed air have for a considerable time been in favour in metal mines in all parts of the world, but in coal mines hand drills are still used, probably owing to the softness of the coal and coal-bearing rocks, compared with the older rocks that are tunneled through in metal mines.

The earliest attempts to make a machine that would take the place of the miner's pick date from the middle of the last century, but it is only in recent years that such machines have come into general favour. The great strides made in electrical engineering, and the increased use of compressed air, are no doubt mainly responsible for the growing extent of their use.

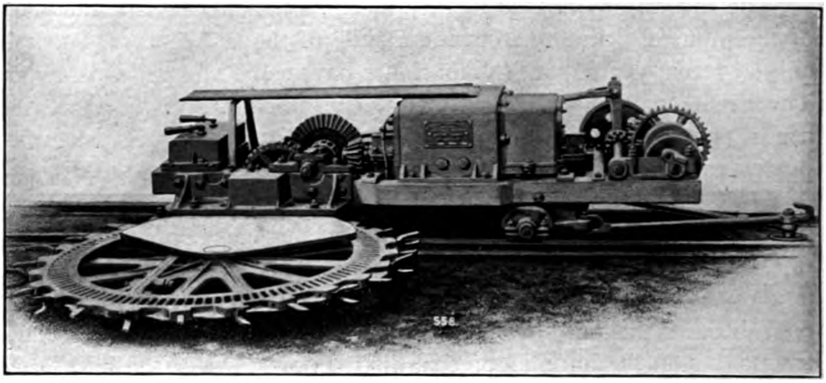
Of these machines there are two main types—the pick or punching machine, and the cutting machine, the former being intended to imitate the action of the miner's pick, while the principle of the latter is a revolving disc, chain, or bar. In England the chief element of opposition to their use has been undoubtedly the cheapness of manual labour, but in the bituminous coal districts of America the high price of labour has enabled coal-cutting machinery to more than hold its ground, in spite of the natural difficulties encountered arising from the highly inclined strata.

The power which seems to be generally best adapted for consumption in operating mining plants is electricity. The simplicity of design, the rotary motion and absence of dead points, the ease of control, and extreme portability, as also



BOX ELECTRIC PERCUSSION ROCK DRILL.

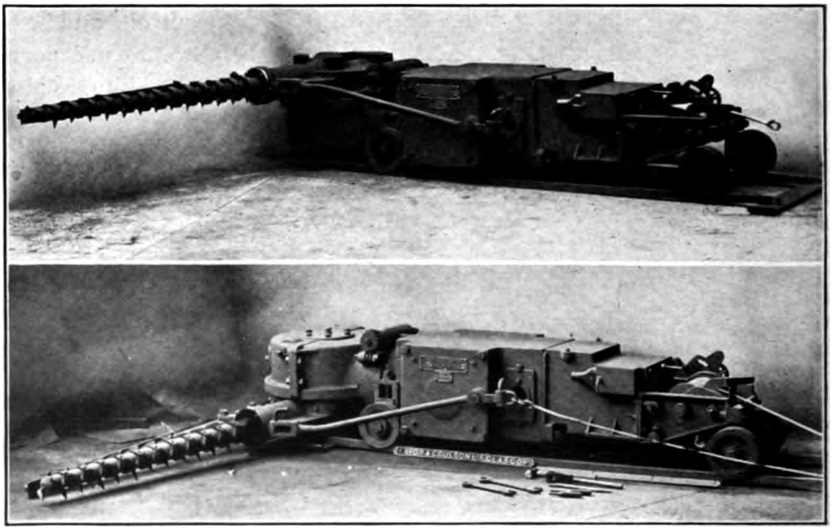
Denver Engineering Works Company, Denver, Col.



DISC TYPE, ELECTRICALLY DRIVEN COAL CUTTER.

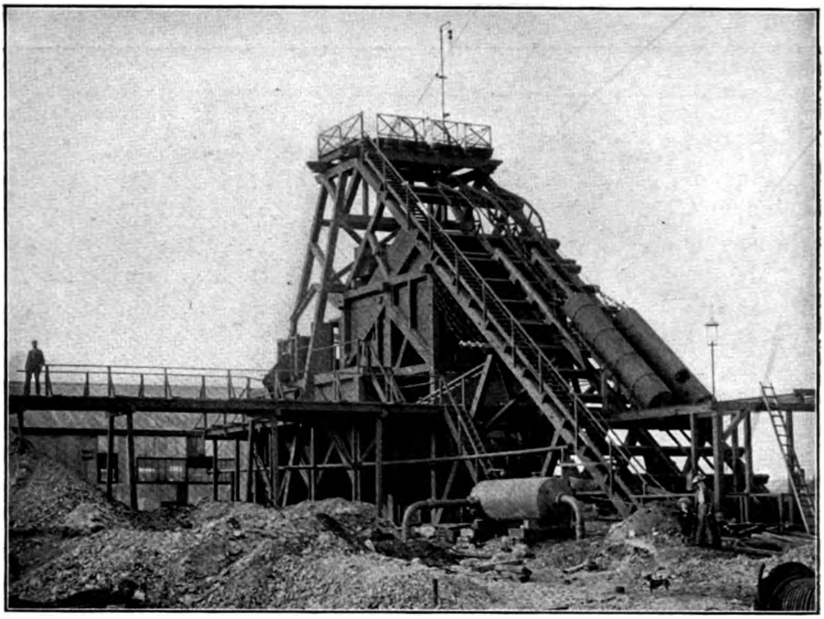
Disc 5 feet 6 inches in diameter; 25-horse-power motor. Ernest Scott & Mountain, Ltd., Newcastle-on-Tyne.

the high efficiency which is now obtainable over a modern electrical installation, constitute the electric motor the agency *par excellence* of which the mining engineer may ask aid. Changes and extensions may be quickly made, and the conducting wires can be carried through the most tortuous passages of the mine—qualities which immediately place it above steam and compressed air. The efficiency too, where the



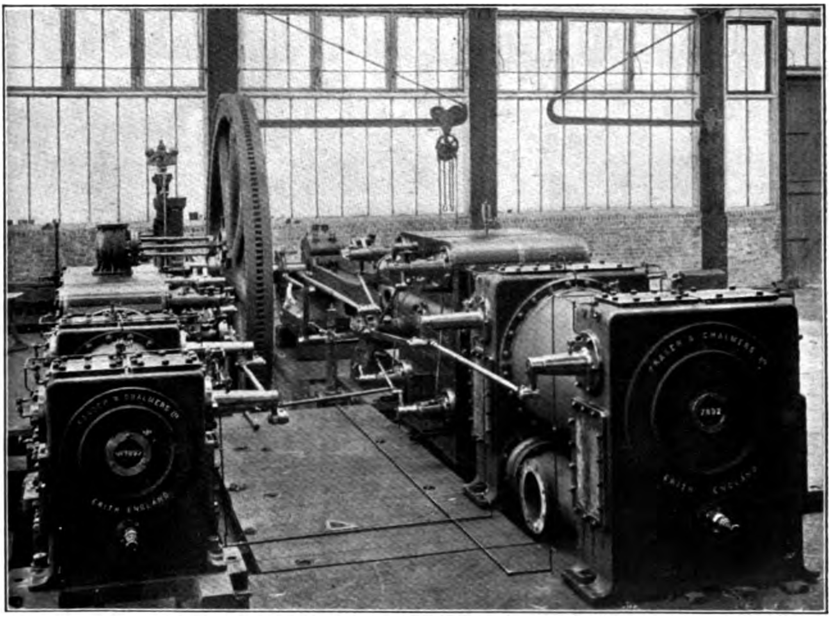
ELECTRIC BAR COAL-CUTTING MACHINE.

In the upper view it is adjusted for over-cutting; in the lower, for under-cutting. Mavor & Coulson, Glasgow.



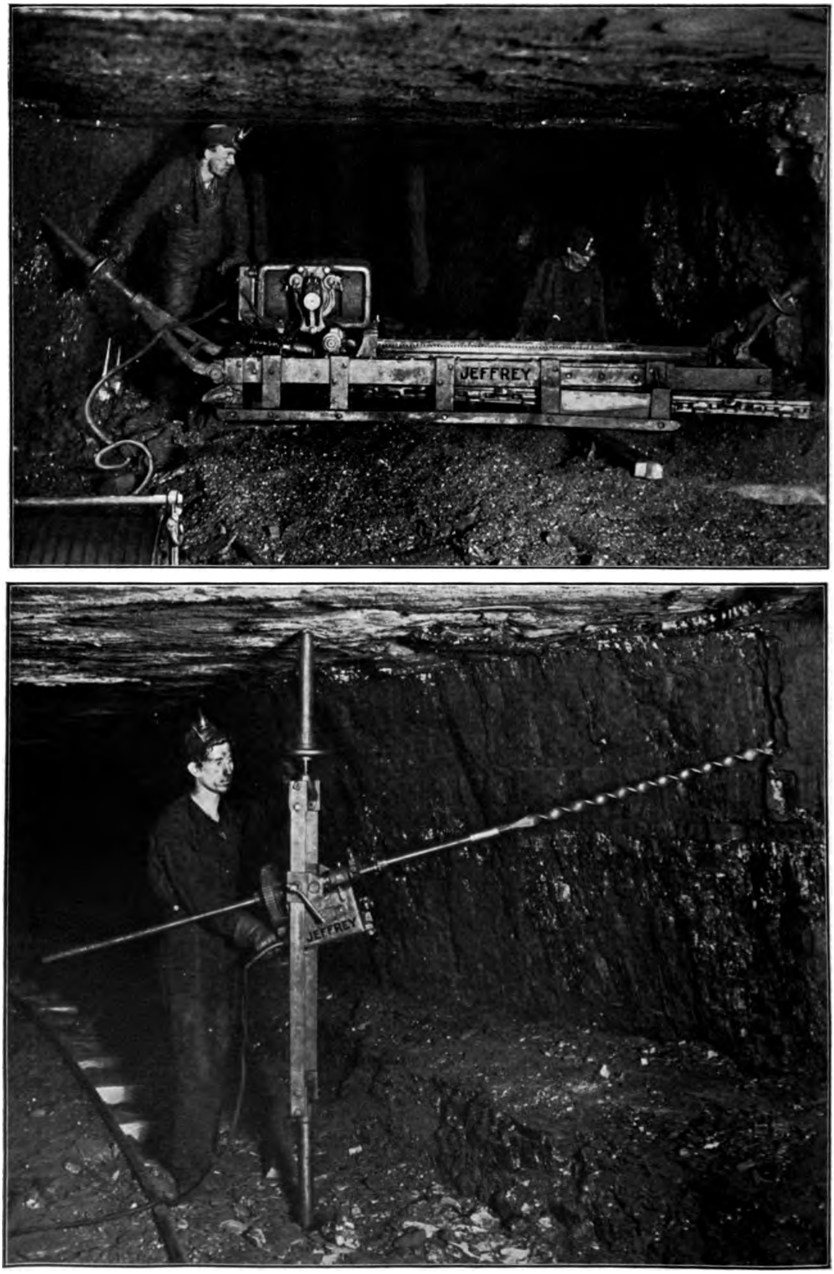
A MODERN MINE. SHAFT HOUSE, HEAD FRAME, AND ENGINE HOUSE, CROWN REEF MINES, JOHANNESBURG.

Showing incline equipped with balers for unwatering the mine after the Boer war. Round ropes, rolled-steel-plate drums, loose on main shaft and connected thereto by powerful band friction clutch. Built by Wellman-Seaver-Morgan Co.

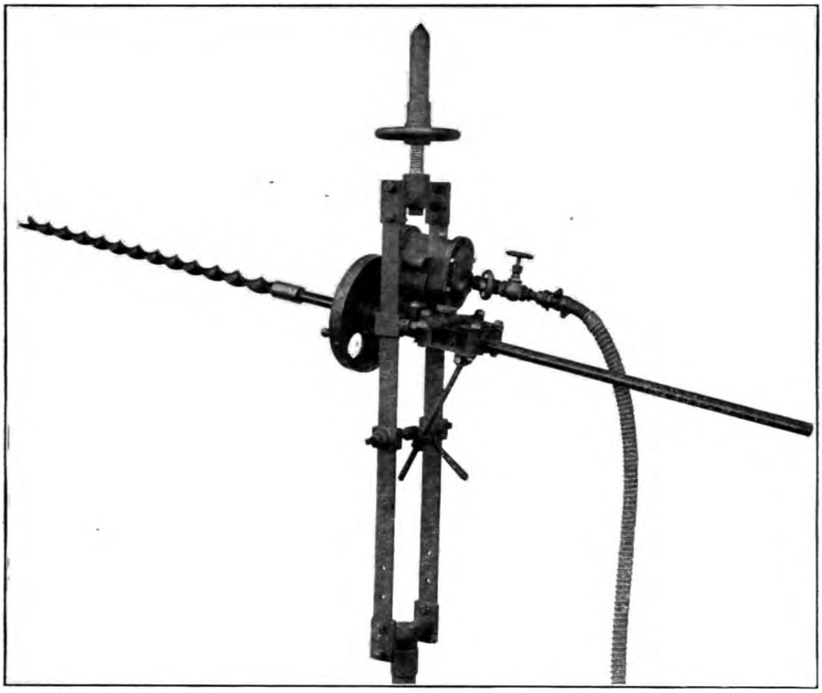


A MODERN AIR-COMPRESSOR PLANT.

3,064 cubic feet free air at 68 revolutions; 75 pounds air pressure with 120 pounds steam, condensing; *jacketed steam* and air cylinders. Fraser & Chalmers, Ltd., Erith, England.



THE UPPER PICTURE SHOWS THE JEFFERY ELECTRIC COAL-MINING MACHINE READY TO START; THE LOWER THE JEFFERY ELECTRIC COAL DRILL AT WORK.



COMPRESSED-AIR POWER COAL DRILL.
Weight 170 lbs.; effective air pressure 60 lbs.; Jeffrey Manufacturing Company, Columbus, Ohio.

transmission is over some distance, is much greater than either steam or compressed air. Electricity can be used as the motive power for every operation in mining, and in one mining district—Cripple Creek, Colorado—is the only power used, being derived partly from steam and partly from water power.

Taking a comprehensive view of the influence that machinery brings to bear on the working of a mine, one is struck with the general idea of thoroughness of system and method that seems inseparable from its use, and which will undoubtedly have its effect not only in the attainment of greater economy in production, but also in the not less desirable result of lessening the danger to life and limb, and materially diminishing the number of accidents to which, alas! all mine workers are liable.

MECHANICAL AUXILIARIES TO THE
OF THE FIREROOM.

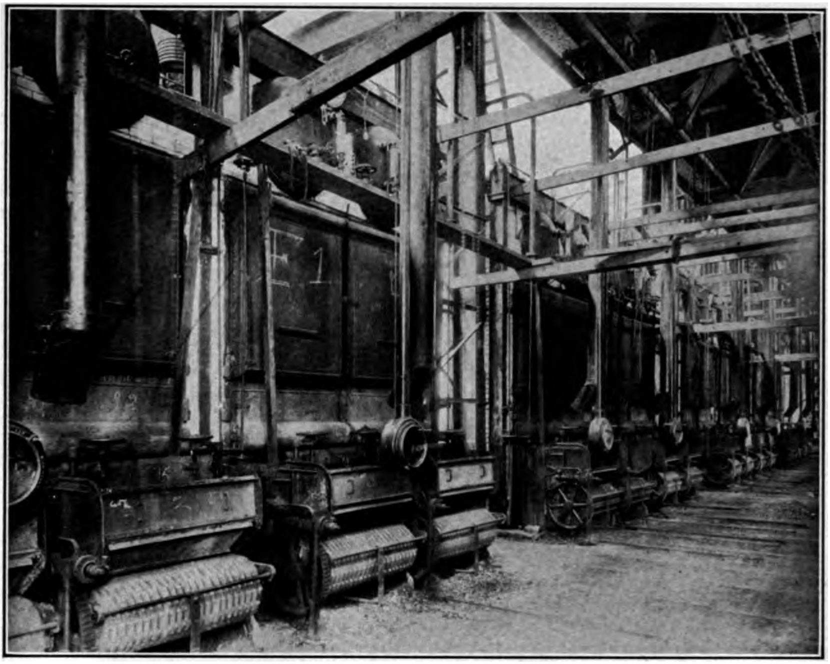
By Reginald Pelham Bolton.

**As the use of mechanical power is the great source of labor eco
itself should certainly be an example of the best practice in economic
less expenditure of labor or of money there places a burden upon ever
the establishment, of whatever kind those units may be. And Mr. Bol
out very clearly the point that every extension of the use of mecha
fireroom not merely improves the physical conditions of the work, but
qualities in the worker. It is a characteristic manifestation of the
machinery.—The Editors.**

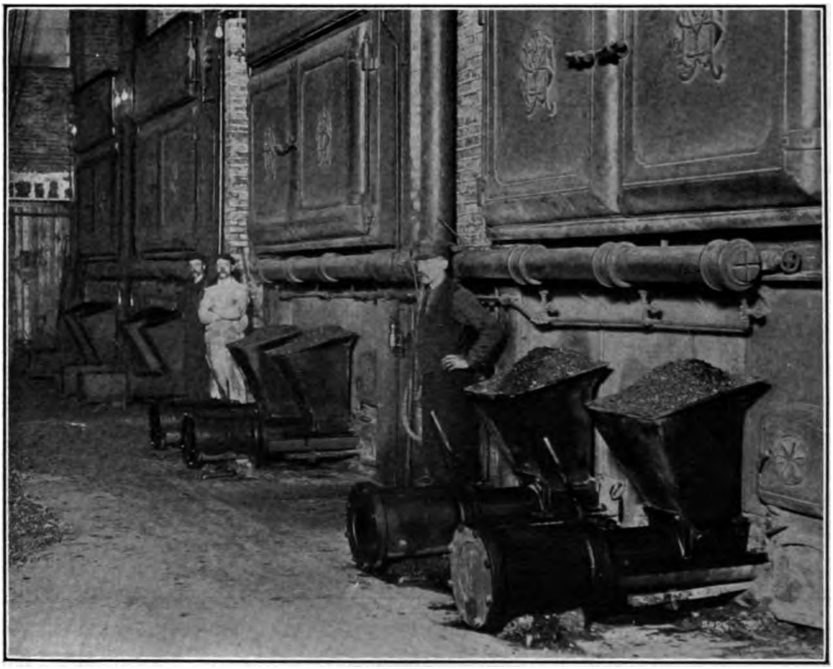
WHILE it is fortunately common
gent attention devoted to the
and designs of boilers, it is u
that the general arrangement
the installation of boilers are, i
of instances, afforded relativel
ation, in general being abandon
circumstances of location and
posed by other apparatus.

The cost of power productio
tion of fuel. With it are inseparably connected the c
proper economy and of handling the fuel. The
ignoring these matters lies, remarkable to say, at the
such apparatus. It is rather an illustrative fact th
of a boiler plant is about equivalent to its coal con
year, and this statement may serve to enforce the i
as to indicate the possibilities of economy in all
with it.

Assuming the purchase of boilers of good form,
desirable elements for the absorption of the heat
them, it still remains necessary, in order to complet
of their operation, that the boilers should not be



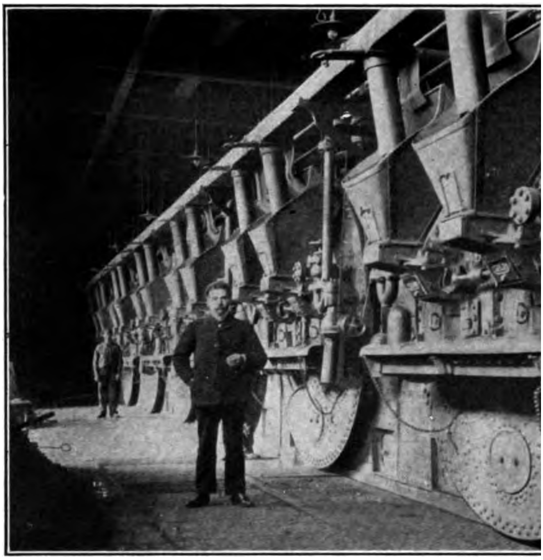
BABCOCK & WILCOX CHAIN-GRATE STOKERS, PINKSTON POWER STATION, GLASGOW CORPORATION TRAMWAYS.



INSTALLATION OF UNDERFEED STOKERS IN DEPARTMENT STORE OF MARSHALL FIELD & CO., CHICAGO.

The Underfeed Stoker Co. of America, Chicago, Ill.

vantage as regards draft, access, handling, and cle
any given condition of position, a decision on the ac
of boiler would properly be based not merely on its i
constructive features, but on its adaptation to the locat
too much to say that there is, for any given arrange
particular form of boiler that is most suitable.



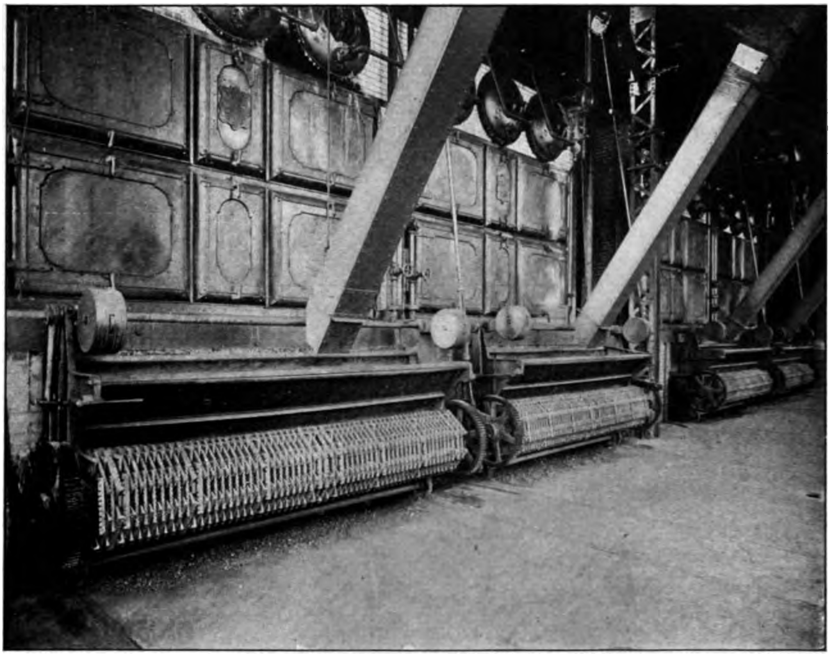
AN INSTALLATION OF BENNIS STOKERS FITTED TO INTERNALL

While the elementary conditions require simply th
handling firing-tools, of drawing tubes, and of access
prising how often boilers are placed without regard to
requirements. The difficulties encountered in the pr
space for such purposes in many buildings are easily
but many of them disappear when considered in conne
the many special types of boilers. But the class of
employed by owners of such property—namely, the ar
ings, who endeavor to solve such problems under t
their acquaintance with boiler construction and p
unfortunately, extremely numerous. They look at th
nonchalance of the uninformed, and with the custom
the most self-confident and self-important profession
and all ages. Their misguided clients by thousands
of unnecessary waste and extravagance, imposed up
own folly in employing architects, instead of enginee

coal shall be burned to advantage. The man who should call in his tailor to decide on his diet would be considered lacking in intelligence, but the owners of property are legion who unthinkingly pay to architects one-twentieth part of its cost to decide, proportion, locate, and limit apparatus actively engaged in eating up their personal assets.

As regards the type of grate and available draft, some decisions are made as surprising as those before referred to. After his plant is installed, it is comparatively rare that a producer of power has taken the trouble to ascertain by comparative test the really suitable class of fuel for his special conditions. Much of such investigating work awaits the engineer in the future.

The multiplication of boilers in one place immediately involves increase of distance from the fuel store, and also introduces the problems of their relation to one another and to the source of draft. Very wide variations are to be found in the arrangements adopted. The most general system is to set batteries facing one another, thus making a central fireroom. This does not possess all the advantages which appear on the face. Practically as much space should be available in



TRAVELING LINK GRATES, KAW RIVER POWER HOUSE OF THE METROPOLITAN STREET RAILWAY, KANSAS CITY, MO.

Green Engineering Co., Chicago, Ill.

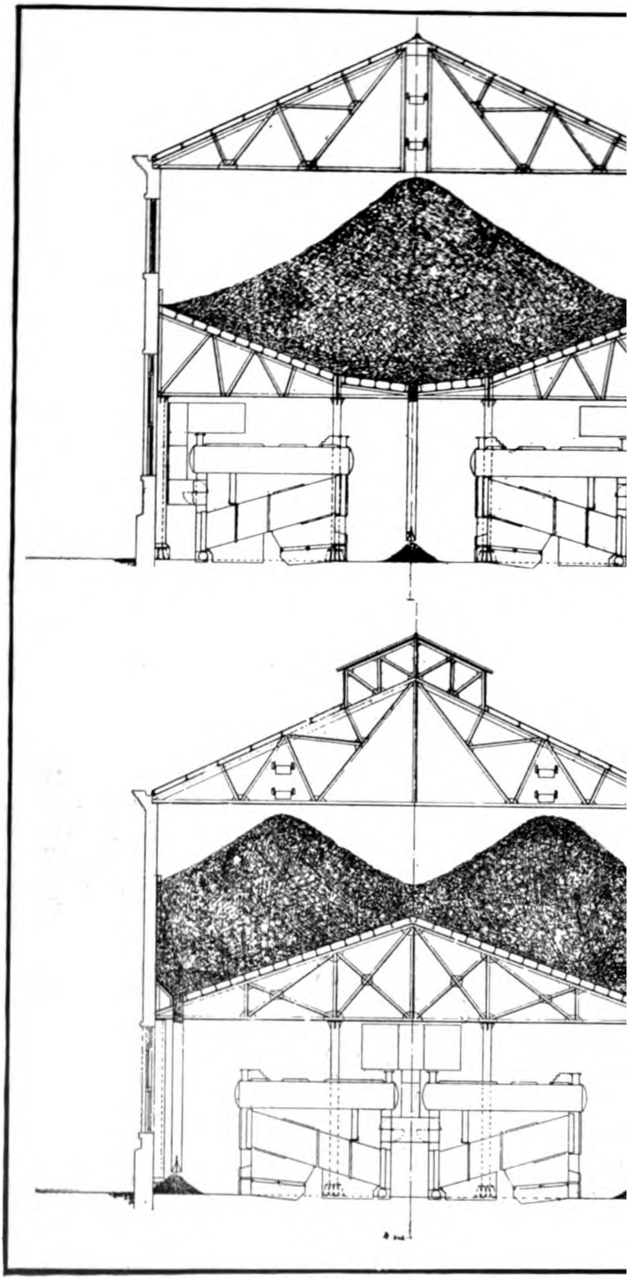
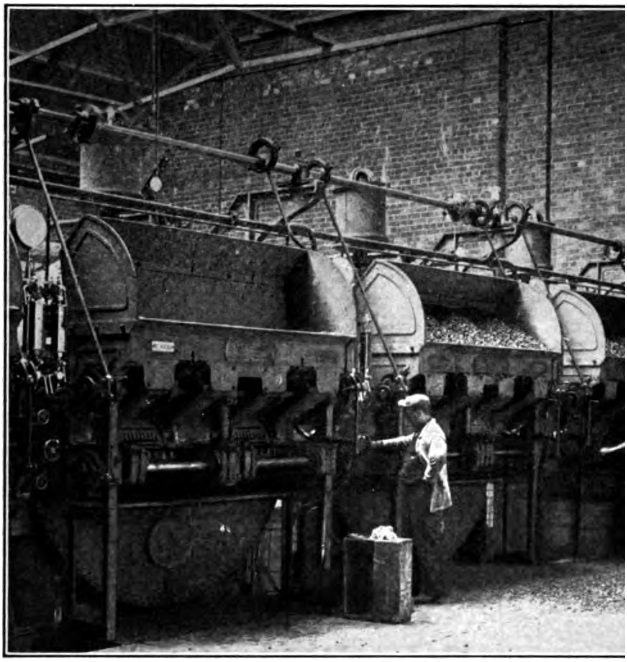


DIAGRAM SHOWING ARRANGEMENT OF BOILERS FACING, AND THE
MORE ADVANTAGEOUS BACK-TO-BACK SETTING IN THE SAME SI

the central fireroom as in two separate rooms, otherwise the men firing opposite boilers are liable to interfere with one another. I have frequently heard this complaint made by firemen, and in such rooms also the heat radiated from the fronts and fires of both batteries often renders the temperature of the room almost unendurable.

Boilers so designed that they could be set back to back, would lose less in radiation. Such arrangements are more common in Europe. The Popp air-power station in Paris is a good example. Here the boilers set back to back, and each fireroom is light and is ventilated naturally—elements counting for much in the amount and character of work done by the firemen, who seem commonly to be regarded as a class of men capable of doing effective work of a character which peculiarly requires intelligence, under conditions of darkness, filth, and heat, which would be scouted as ridiculous if applied to any other class of labor. Especially is this the case in firerooms on shipboard. Taking into account the fact that a fireman not only stands for a labor cost, which in New York amounts to $720 per annum, but that he may directly handle as much as $10,000 worth of his employer's property, the results of which his carefulness, ability, and even his state of health, may largely affect—it would seem as if more attention should be paid to the conditions under which these employees work. On the contrary, in a very large station the manager quite recently told me that they picked up firemen anywhere and let them go ahead and fire in their own way, keeping some control of the results by retaining the handling of the draft of each boiler in the hands of a water tender. This illustrates the process of reduction of the fireman to a mere shovelling machine, with just sufficient knowledge to be able to tell when a hole is showing in the fire, and not enough judgment to avoid unnecessary opening of the fire door.

In all other trades some system exists of training men to their work. But in this, the most elementarily important craft, the men are allowed to pick up the knowledge hap-hazard, one by shipping on a vessel burning soft coal burned under furious forced draft—another in a saw-mill shovelling sawdust, wood, and coal alternately—another in a hard-coal battery, and so on through the gamut of possible variations of fuel and draft. A school of training for firemen would present a large opportunity of advantage, and its graduates should find great openings for advancement. When special results are to be obtained from a boiler, it is customary to find an expert fireman employed, whose ability not infrequently has attained results unattainable by the ordinary employee. What one such man can do might just



VICARS' STOKERS APPLIED TO LANCASHIRE BOILERS, POWER ST
CORPORATION TRAMWAYS.

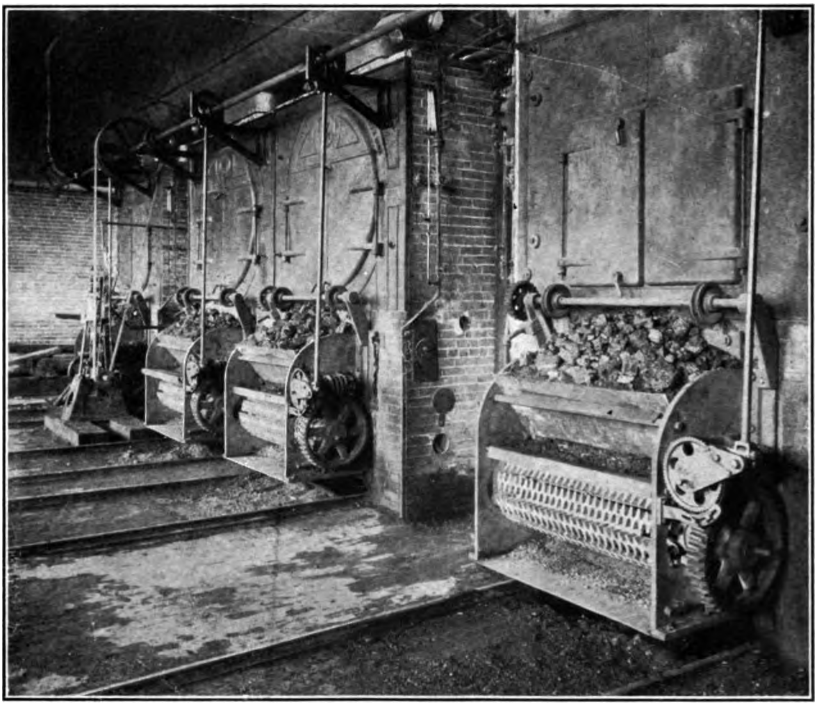
as well be done by others. Yet owners frequently e
the employment of such a man on boiler-economy t
their work "fancy firing," and belittling the resul
afforded to the regular employees is sometimes igno
accepted.

There are probably more than three thousand
New York city alone in shovelling coal into fires, s
tunity for improvement is great. This state of aff
chief reasons for argument in favor of the adopt
apparatus, which are almost to be characterized as
not be possible within the limits of this article to ente
of their respective merits and advantages. The mai
oped by the experience of users seem to be that the
stokers is advantageous in installations in continuous
but that where fuel varies in character and in quanti
burned, hand firing still shows advantages. The
large installations, where the load is variable, is that
are utilized in a certain portion of the plant, affor
fixed output or within moderate limits of variation,

is utilized on the remainder of the battery for variable and for emergency output. This result is much the same as has been experienced with all other forms of automatic apparatus, which leave, after all, a certain use for manual labor.

In the adoption of automatic stokers it does not necessarily follow that the fuel must automatically be supplied to them. There are, of course, many cases where this cannot be done, and the employment of firemen or coal passers is continued, to lift the fuel to the feeding hoppers. In large modern installations, however, the mass of fuel is elevated and stored in quantity, and arranged to be delivered by gravity to the desired point. For such work the smaller sizes of anthracite are peculiarly adapted, especially in what may be called "interior installations"—those inside dwellings and factories.

Automatic firing has certainly a pleasing aspect as a general proposition, but has produced quite as large a crop of disappointment as of satisfaction. This has been due largely to the lame method of adapta-

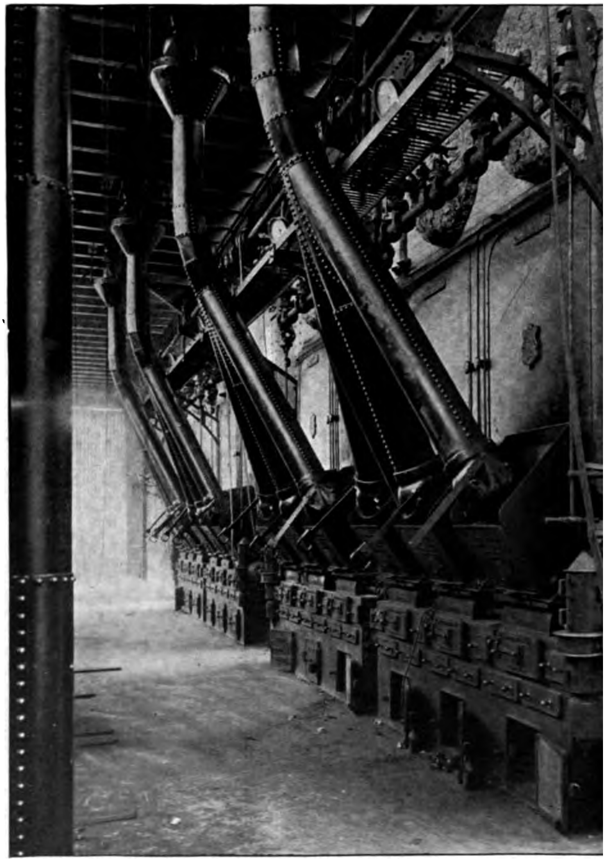


AN INSTALLATION IN THE BOILER PLANT OF THE SUPERIOR SHIP-BUILDING CO., WEST SUPERIOR, WIS., BURNING RUN-OF-MINE COAL.

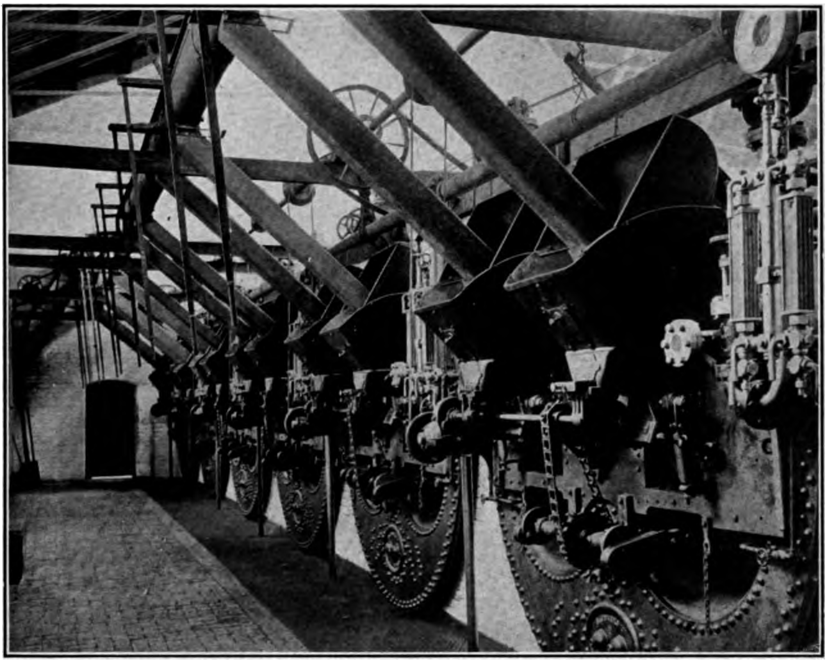
Duluth Stoker Co., Duluth, Minn.

tion of apparatus on the responsibility and recomn
tentees and manufacturers, and owners of plants hav
ces only themselves to blame for accepting the se
blandly made to them by insinuating agents, with
technical advice. There are stokers and stokers, som
unsuited to conditions which would produce excel
other types. It is quite certain that in one, if not m
power houses in New York, stokers are working
visit to the rear of their boiler batteries and a climb
burned-off grate bars, will bear testimony strongly
view.

One power house has stokers which are expected
or soft coal, as it may happen to reach them. Anotl



INSTALLATION OF COKER STOKERS, BRISTOL ELECTRICI
Meldrum Bros., Limited, Atlantic Works, Manche



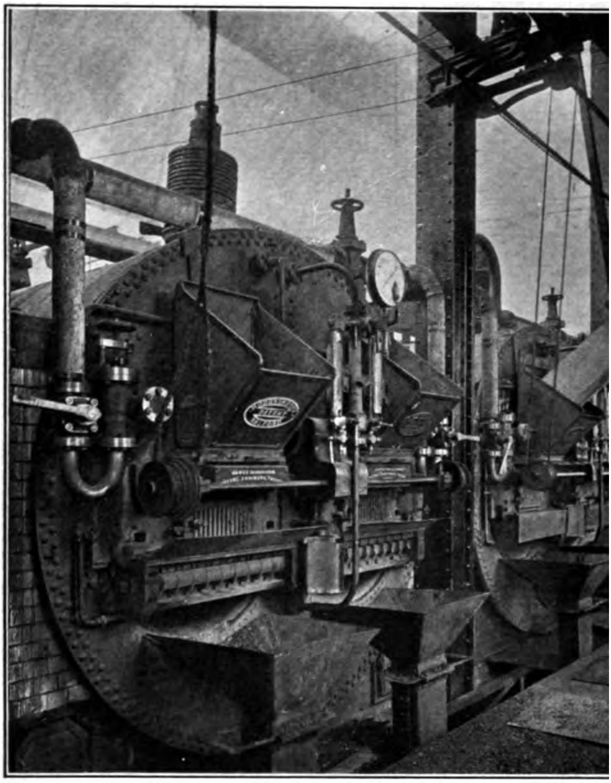
PROCTOR'S SHOVEL STOKER APPLIED TO FOUR EIGHT-FOOT LANCASHIRE BOILERS, NEW HYDRAULIC STATION OF NORTHEASTERN RAILWAY, MIDDLESBORO.

The stokers are fitted with a complete coal-handling plant, delivering coal automatically to the stoker hoppers by elevators and conveyors. Proctor, Burnley, Lancs.

mentioned, cut the difficulty by installing stokers under only one-half the plant. These are plants designed under the "committee" system, in which a number of engineers are brought together from different parts of the country and are directed to settle in concert the various questions of type, design, and economy. The vital details are worked out by the cheap staff of the corporation. This method produces the diverse and often confusing arrangements which can be compared by a trip from 38th street to the Harlem. It is natural that in such haphazard combinations, the stronger will dominates the weaker, and therefore, in the work of one such committee may be seen the dominance of Cincinnati or Chicago, and in another that of Boston or Baltimore, while the underlying local conditions have to take a back seat.

It is interesting to observe the effect of these sporadic efforts of great corporations to avoid placing responsibility on one man's shoulders, and above all to evade the cost of employing experts on details.

A common allowance of labor for the purpose of firing is to allot



AN INSTALLATION OF HODGKINSON'S STOKERS AT THE NEW SA
STATION.

James Hodgkinson, Salford, Manchester.

one man to a rating of 500 horse power. This a v
tity, since that capacity may, under conditions of ec
gance, require the burning per hour of 1,500 or
coal, a difference of nearly two to one. Marin
a man to 54 square feet of fire-grate surface—a
vide a man to three ordinary furnaces of an int
tubular boiler; but here again conditions vary so gr
so allotted may require the handling, under condi
moderate draft, of quite as great a difference in ma
making any comparison with the use of automatic s
lar conditions must be examined. On an assumed b
ment of six men to 3,000 horse power, handling, s
11,000 pounds of coal per hour, the use of automatic
the same economic results, be taken to save 1/5 of t

the men are still employed to feed the coal to the apparatus. With the use of automatic coal-conveying apparatus or delivery by gravity to the stoking hoppers, the labor would be reduced to that of two men. They should however, be of a better paid (because better informed) class, so that the relative reduction in terms of wages would be approximately only about one half. This matter settles itself in large cities, where the firemen are under any circumstances required to be licensed. More exactly figured, the comparison works out as follows, on a plant in which I have had the opportunity of making a close comparative observation and calculation of the costs under mechanical and hand-stoking methods of firing.

The plant consists of 3,000 boiler horse power, evaporating just over 9½ pounds of water from and at 212 degrees, per pound of dry coal, and when fully occupied the men may handle, with 2 per cent. of moisture in the fuel, a weight of about 11,000 pounds per hour. Such a battery would consist of, say, 10 units of 300 horse power each, and under New York city conditions, with natural draft, would have from 600 to 850 square feet of grate surface.

The operating force required for a 24-hour load service, 12 hours day load with easy firing at night on three to four boilers, 10-hour shifts, is as follows:—

I.—Hand firing.

	Wages.
Two men, 1 p. m. to 10 p. m., clean fires at 8 p. m., one at	$ 720
and one, being a leading fireman, at	800
Two night firemen, keep steam 10 p. m. to 8 a. m. and clean fires before 8	1,440
Four firemen, come on 8 a. m. to 6 p. m., and clean fires 12 and 4	2,880
Water tender on duty 8 a. m. to 6 p. m.	840
Three coal passers, 6 a. m. to 6 p. m.	1,512

The arrangement gives:—

Four men and water tender from 8 a. m. to 1 p. m., when moderate load is required.
Six men from 1 p. m. to 6 p. m.—heavy load.
Two men from 6 p. m. to 10 p. m.—decreasing load.
Two men from 10 p. m. to 8 a. m.—night load.

Total wages per annum $8,192

II.—Automatic Stokers, hand-fed.

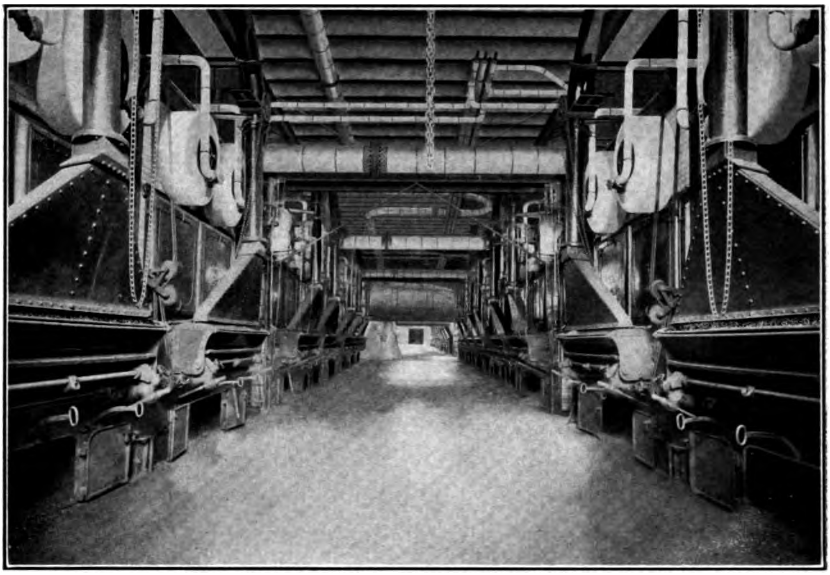
With automatic stokers the same class of labor must be employed, as the men must be licensed firemen. Two men must be kept on at night in case of accident to one. Night work and day work reduced to lifting coal to hoppers; no cleaning of fires.

	Wages.	
Two men, 1 p. m. to 10 p. m., as above	$1,520	
Two men, 10 p. m. to 8. a. m., as above	1,440	
Two men, 8 a. m. to 6 p. m., as above	1,440	
One water tender	840	
Three coal passers, as above	1,512	
This arrangement gives four men between 1 p. m. and 6 p. m.		
Total wages per annum		$6,752
Add part of engineer's wages in maintenance of stoking apparatus, say, one-third of an assistant engineer's,		$320
Interest on cost of stokers, say, $10,000 at five per cent.		500
Depreciation and replacement of bars, say		680
Total		$8,252

Thus the combination of circumstances and of requirements here shows a loss by the mere adoption of automatic stokers.

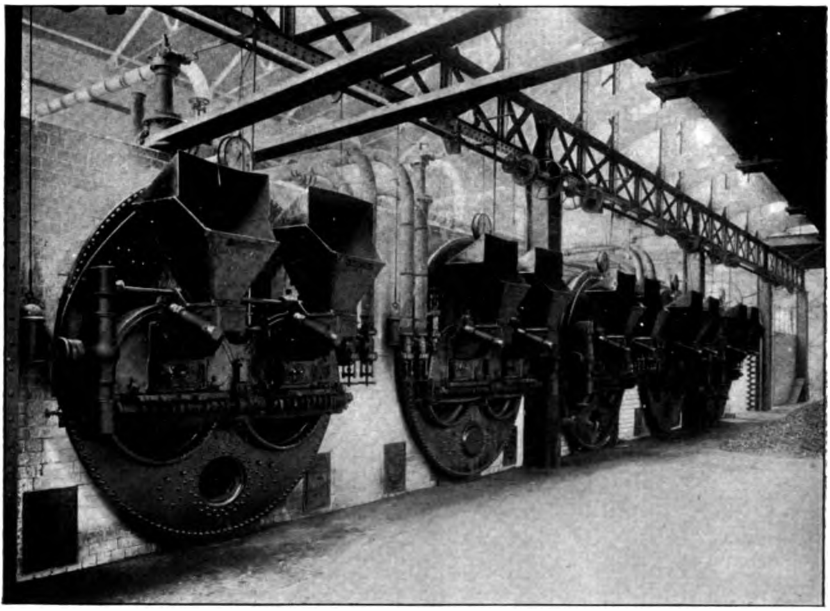
It would be argued however, by exponents of such apparatus, that the stokers would enable less boilers to be operated at a higher rate of evaporation and that this would reduce the labor involved. But against this view must be considered the fact that the labor of coal lifting is already enlarged by the increased heights to which, in most such apparatus, the fuel must be lifted to the hoppers. Further, even were the total coal labor considerably reduced, it would not, in such a plant as this, permit a further reduction of labor, because the security of a large battery and the increase of maintenance of the supply demands the attendance at all times of not less than two men.

The results to be effected by the addition of these stokers of coal-handling apparatus or gravitating arrangements puts a better complexion on the question, because it immediately dispenses with the services of two out of three coal-passers costing $1,512 per annum, the third being necessarily retained for handling ashes out of the fire-



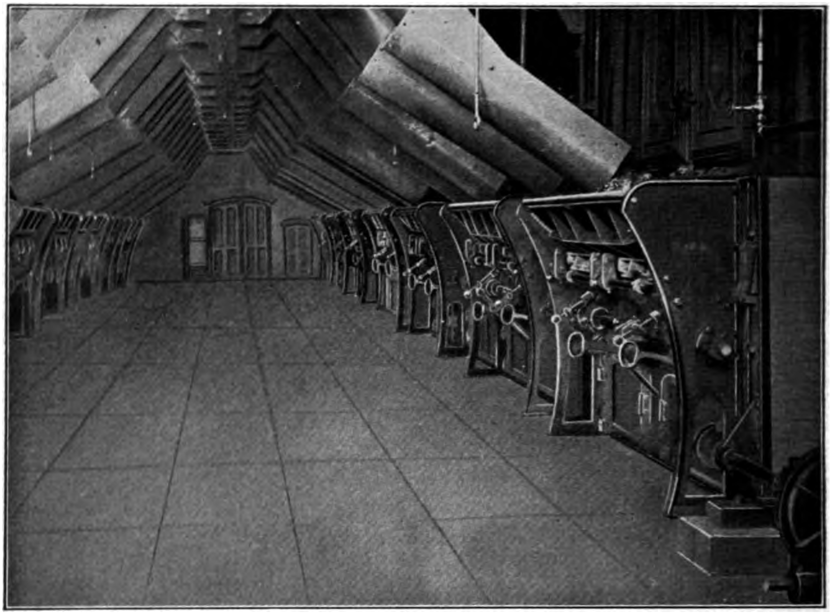
RONEY MECHANICAL STOKERS, 96TH STREET POWER HOUSE, METROPOLITAN TRACTION CO., N. Y.

Westinghouse, Church, Kerr & Co., N. Y.



INSTALLATION OF TRIUMPH STOKERS AT THE NEW CORPORATION ELECTRICITY-SUPPLY STATION, HYLTON ROAD, SUNDERLAND, DURHAM.

Triumph Stoker, Limited, Ransomes & Rapier, London and Ipswich.



4,000-HORSE-POWER BOILER INSTALLATION FITTED WITH ROSS STOKERS, CLARION MILL OF THE NEW YORK & PENNSYLVANIA CO., JOHNSONBURG, PA.

room. Furthermore, as there is now no labor for the firemen, no more than two need at any time be kept on duty, and of these the water tender will answer for one during his hours of duty, so that we get by a re-distribution of labor:—

One water tender, 8 a. m. to 6 p. m.	$ 840
One fireman, 4 a. m. to 2 p. m.	720
One " , 2 p. m. to 12 midnight	720
One " , 6 p. m. to 4 a. m.	800
One coal-apparatus tender 7 a. m. to 7 p. m.	600
Interest, replacement, and depreciation on automatic stokers, as above	1,180
Interest and depreciation on coal-handling apparatus, at 12 per cent. on $6,000	720
Proportion of engineer's wages, say one-fifth of $960	192
	$5,772

This shows an attractive saving of $2,480 per annum, or about 4½ per cent. of the total cost of the plant, and a similar proportion of the coal bill. Therefore if the physical conditions of the situation of the boiler room permitted the use of the coal-handling plant, then the use of automatic stokers would be, in this case, desirable. As a matter of fact, in the particular plant from which I have drawn this illustration, considerable physical obstacles existed, and there was a further objection on the part of the owners to the possible vibration or noise from the use of such apparatus below their building.

I am free to admit that in much larger boiler plants, the minimum labor element would bear a less proportion to the whole, and consequently relative economies would be greater. Therefore, it is probable that the point at which a hand-fed system of automatic stoker will show an economy in labor, will exist in a battery of some proportion exceeding 3,000 horse power.

Undoubtedly much economy in the betterment of evaporative results has been obtained in many instances by the application of automatic stokers, but it should be demonstrated, before crediting this result to the apparatus, that the same amount of improvement might not have been effected in other directions. Thus, it will be observed

AMERICAN STOKERS, UNDERFEED SYSTEM, AT THE HOMESTEAD MILLS, CARNEGIE STEEL CO., UNITED STATES STEEL CORPORATION, PITTSBURG, PA.

American Stoker Co., N. Y.

by a comparison of some of the claims of, and of the tests run upon automatic firing, that they usually attain high results by running up the output of the boiler, or in other words by working it over its "rated" capacity. There are numbers of boilers which could be improved in their performance by the same treatment under hand firing, because the "rated" capacity is in just so many instances "under-rated," by reason that the "rating" ignores the fuel and draft conditions.

When the conditions admit of the gravitation of the fuel to the fire room, and of the gravitation of the ash and clinkers to receptacles below, a very ideal condition is reached, removing the cost of labor in handling, and eliminating much of the unintelligent class of labor from the installation, but introducing the new element of the employment of men capable of handling motive machinery. Such mechanical additions to the fire room tend to increase, in the form of coal crushers, forced-draft systems, coal and ash hoists, and mechanical tube cleaners. For much of the work of the fireman and coal passer, is substituted a percentage of the steam power raised.

An element of large capability of economy which is in wide use on shipboard, is not yet much availed of on land, viz., the use of heated forced draft, which in the hands of skilled operators affords considerable future possibilities. It may here be mentioned that systems of forced draft by steam jets or by fan, are liable to misuse by ignorant firemen, even to the extent of throwing upon their fellow laborers part of their own share of work. The common system of connecting all boilers of a battery together, affords no opportunity of comparing the work of one fireman or one boiler with another. It is not uncommon to see conditions where one boiler is doing no work at all, while its neighbor is forced over its rating.

All these considerations lead back to the fundamental requirement of human intelligence in the fire room, and the need for such intelligence is not lessened by the march of modern improvement, but rather increases. There will not be, even with a much more general adoption of automatic apparatus in the smaller class of installation, any less need for knowledge on the part of firemen, or even of the more mechanical attendants upon modern automatic apparatus.

Courses of study in firing and kindred subjects could with advantage to the community at large, be established by our colleges. It is a subject which directly and greatly affects the pocket, as well as the resources of the nation.

THE RELATION OF ELECTRIC INVENTIONS TO HUMAN ACTIVITY.

By Louis Bell.

It is plainly impossible even to list the myriad special applications of electricity. Dr. Bell therefore discusses only the great fundamental inventions, but with rare discrimination in apportioning their influence, and with even rarer interest in the presentation of the subject.—The Editors.

ONE is very apt to confuse the bearing of inventions upon human affairs by mistaking inventions of convenience for those that produce a deep and lasting effect upon civilization through profound changes in the efficiency of industry. The inventions which directly increase the scope of a man's efforts, mental or physical, stand on a very different plane in relation to the world's progress from those which merely give him new luxuries or employments. Viewed in this perspective, the advances of the nineteenth century take on an appearance altogether different from that which they present at a casual glance.

We live, for better or worse, in a work-a-day world, and those evolutionary changes are most effective which diminish the effort required for producing necessities and thus set free time and activities for racial progress. No people ground down by eternal toil can advance rapidly, mentally or physically—least of all, spiritually. The effect of the inventions of the last century in liberating human energy for use in general progress has been tremendous, and in this great work the electrical advances of the latter half of that century have played an important rôle.

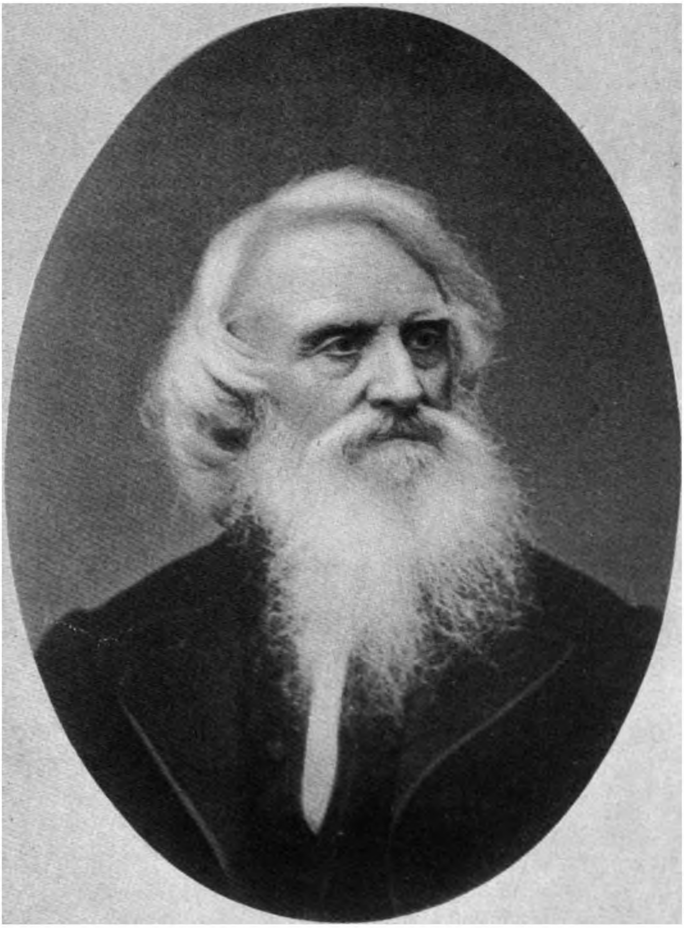
Yet they have a certain scintillant quality that tends somewhat to exaggerate their real effect upon civilization as a whole. For example, no electrical invention has produced results so deep and far-reaching as the locomotive or the steam boat, and very few have reached the importance of the power loom or the sewing machine. Very possibly the importance of the former pair may not again be equalled for centuries to come, and it is altogether improbable that the present century will equal the past one in its achievements, so far as fundamental inventions are concerned. We shall see numberless scientific discoveries and inventions of convenience. A type of the latter class was the invention of photographic processes.

The first notable electrical invention of the nineteenth century was the electromagnetic telegraph. The story of the struggles and triumph of Morse and of his associates is a dramatic one, and the final result, girdling the earth with cables and covering it with a network of communications, has had an immense effect in improving the mechanism of commerce and facilitating the distribution of industrial output. Yet this involves only an indirect effect on the conservation of human energy. It would be very interesting to know the actual number of separate persons who send and receive telegrams yearly, but the total would probably be surprisingly small, and of the telegrams sent only a rather small proportion would prove to be of such a character as not to be replaceable by letters without any industrial or material loss. Of the value of telegraphy in the dissemination of news there is no doubt, and yet it would be hazardous to say that anyone is sensibly wiser, happier, or richer for knowing within six hours the repulsive details of a massacre in Macedonia or a lynching in Oklahoma.

But the electromagnetic telegraph, although from the purely industrial standpoint it fails of being an invention of the highest rank, still was a tremendously potent factor in electrical advancement. It was the first brilliant success in the applications of electricity, and it stimulated research to an extent that can hardly be realized by those of us who belong to a later generation. Telegraphy was the first, and for years the only, school of electrical science, and its graduates were in no small degree the moving force in later improvements and discoveries. And telegraphy itself called forth inventive talents of a very high order. Edison's work on the "ticker" and the "quad" would have given him a conspicuous place among the great inventors of the century even if he had accomplished nothing else.

Telegraphy was the one vital stimulus of electrical science for at least a quarter of a century. And then came that epoch-making and incomparable improvement, the invention of the dynamo electric generator. Like many another great invention, it can fairly be ascribed to no single person, although the names of Siemens and Gramme will always be those most intimately connected with its history.

The dynamo gave at last the power of obtaining electrical energy in any required quantity by a direct transformation of mechanical energy. It made it possible to draw without limit on the eternal forces of nature for energy in its most versatile form. Without the dynamo, no serious industrial use could be made of elec-



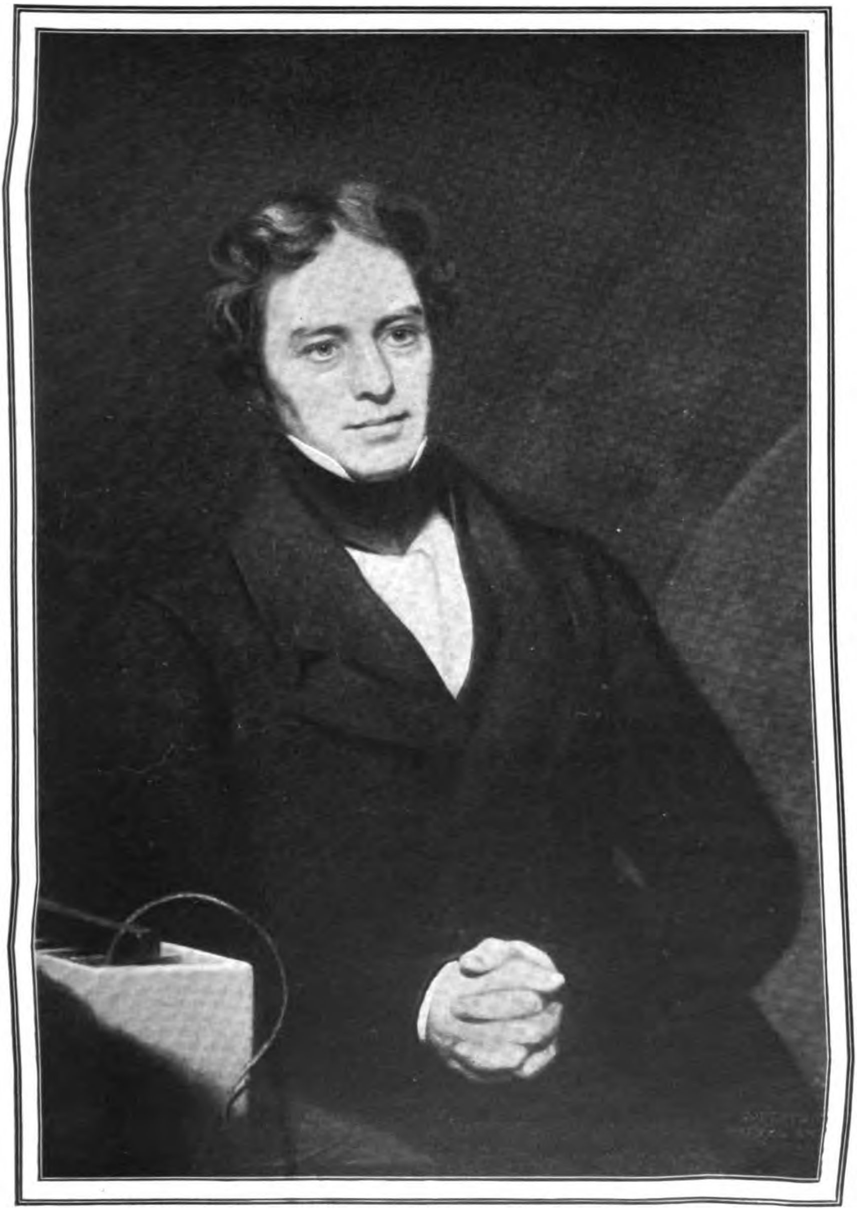
SAMUEL F. B. MORSE. 1791-1872.
Studied art under Benjamin West, and was one of the founders of the National Academy of Design. Began work on the electro-magnetic telegraph in 1835, and established the first line, by United States Government aid, in 1844.

tricity; with it, the whole mighty growth of the electrical arts became almost a matter of course. Before the change could be realized, the laboratory experiments of a quarter of a century became fully commercial enterprises, and struck out new arts. Sooner or later the fruits of research are always reaped by humanity, and in this case the harvest was incalculably great.

The reversibility of the dynamo was a corollary of its invention, and the electric motor, the most striking recent addition to industrial powers, quickly made its way into the world's workshops. It took a few years to bring the world to a realization of what the electric motor could do, but from those first experiments at Sermaize in 1878 has come an industrial force that can hardly be overestimated. The names of Chrétien and Félix are today half forgotten, but they should be blazoned high as the pioneers in the utilization of electric power in both stationary and moving motors. Others had talked and experimented and built models—Chrétien and Félix did the thing itself, in a practical way and for a practical purpose. Aside from all its facility of application, and its marvellous adaptability to labor-saving methods and mechanisms, the electric motor has given mankind the power of controlling and utilizing natural forces in the industrial arts.

The continual draft on the world's fuel supply, which even now menaces the permanence of industries, cannot be checked save by the utilization of permanent natural sources of energy—water power, and wind power, and sun power—in lieu of the limited and stored energy represented by coal. And such utilization today practically depends upon the electric motor. The centers of human industry at the present time are in regions depending upon fuel, not only for their supply of energy, but for their very habitability. Mankind is like a reckless spendthrift throwing to the winds his heritage of energy and sooner or later—perhaps sooner than we think—the end must come. Then must ensue a world struggle for the maintenance of the conditions of existence, and the only hope will lie in the natural powers that, arising in the last resort from solar radiation, will last until the sun grows cold.

But before the electric motor began its momentous career there came, almost like a thunderbolt out of the clear sky, an electrical invention so startling and sensational in its character, so brilliant in its conception and of such prodigious usefulness in its results, that it will probably be written down in history as the most striking single invention of a century almost uniquely productive of marvels. The speaking telephone occupies a place quite by itself. It comes nearer to black magic than anything of human devising since the dawn of history.



MICHAEL FARADAY, F. R. S. 1791-1867.

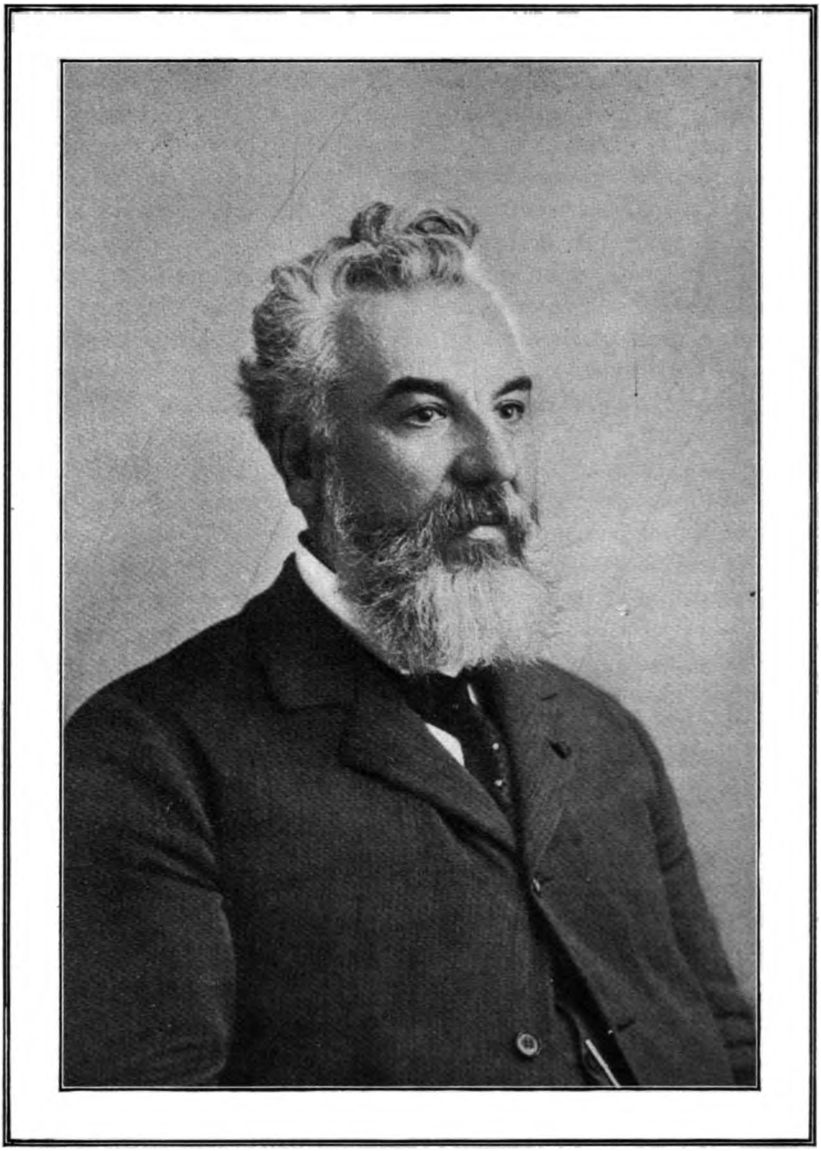
From Phillips' portrait, National Portrait Gallery. Copyright by Walker & Cockerell.

Famous for his work in experimental chemistry, electricity, and magnetism. While his work was exclusively in pure science, he laid the foundations on which the later inventors based their practical discoveries and industrial applications.

As an energy-saving device the telephone far c ventions classified as great. Within its own particu fulness—the saving of time in necessary communicat parably more efficient than the telegraph, since it ca three-minute conversation more than could be done b of half a dozen telegrams extending over a couple of this, it has an immense value in local communication out the field of telegraphy. Aside from its importa time of business and professional men to an extent be calculated, it also takes a very high rank as an inv ience, in facilitating general communications of pure est. It bears a relation to that part of industry which depend upon manual effort comparable only to the sul matic machinery for hand work, and in its relation and methods of a complex civilization it should p as the greatest single invention, aside from printing

In case of the telephone it is possible to get an of the extent to which it is used in everyday affair States alone there are in regular use close on to two n so that it would probably be well within bounds to sa people come within their sphere of influence. As probably be reckoned as occasional users of teleph sum total rises to twenty or twenty-five per cent. of tion. This is the more remarkable as the telephone i ordinary labor-saving devices which one naturally very extensive use. It does not, of course, reach to industry, as do inventions which increase the effi labor, or bring to hand the forces of nature; but o considerations its position is unique.

Almost simultaneously with the telephone the art ing was developed. The idea was not new to the ti and crude incandescents had been known for man substitution of the dynamo for the battery made p mercial enterprise what had before been a mere lab How great has been the growth of the art he wh There has been no one great invention in electric light resistance incandescent lamp, but the art has grov multitude of small inventions and adaptations, all toward progress, and so interlocked that it is hard one which is not inseparably linked with several financial evidences of material progress, in capital



ALEXANDER GRAHAM BELL. BORN 1847.

Inventor of the telephone, for which patent was granted Feb. 14, 1876. He was professor of vocal physiology, Boston University, and a student of the art of enabling the deaf and dumb to enunciate intelligible sounds. Transmitted musical tones by an electric circuit in 1873, and made a practical telephone for the transmission of articulate speech in 1874.

earnings, the stimulation of electrical manufacture
cial importance generally, electric lighting is a migh
resources of civilized communities. Yet, oddly enc
reckoned as either touching deeply the foundations
acting directly upon human efficiency. Doubtless,
upon the whole better ordered through the brilliant
the electric light has made possible. Doubtless, too
has tended to the production of more and better wo
ing establishments. But electric lighting could pass
the next decade without affecting deeply either othe
general progress of civilization. Its strongest hold
portance lies in the fact that it enables the necessary
lighting to be done, if need be, without drawing on
of stored energy. It seems at first sight rash to rel
in itself so important an industry as electric lighti
order of importance, yet if the touchstone of perma
conservation of human energy, just this step must
But it must not be forgotten that electric lighting
development of dynamic electricity just what the
voltaic electricity. It has been the school of electric

The electric railway belongs in a different cate
its intimate connection with the daily life and labors
In and about urban communities a vast majority
directly derives benefits from electrical traction. Th
by enormously increasing the facilities for trans
the burdens of a large part of the community, a
labor or other purposes to an extent that produces
in the better utilization of human energy.

In the first place, as an absolute saver of time the
electric railway is enormous. The time spent in tran
economic loss, for it is unproductive, and unlike w
tion, it has no secondary value as a mental and ph
time saved from transportation must rank as an e
the electric railways are especially valuable in thi
the fact that they are of daily utility to the people
with hand or head.

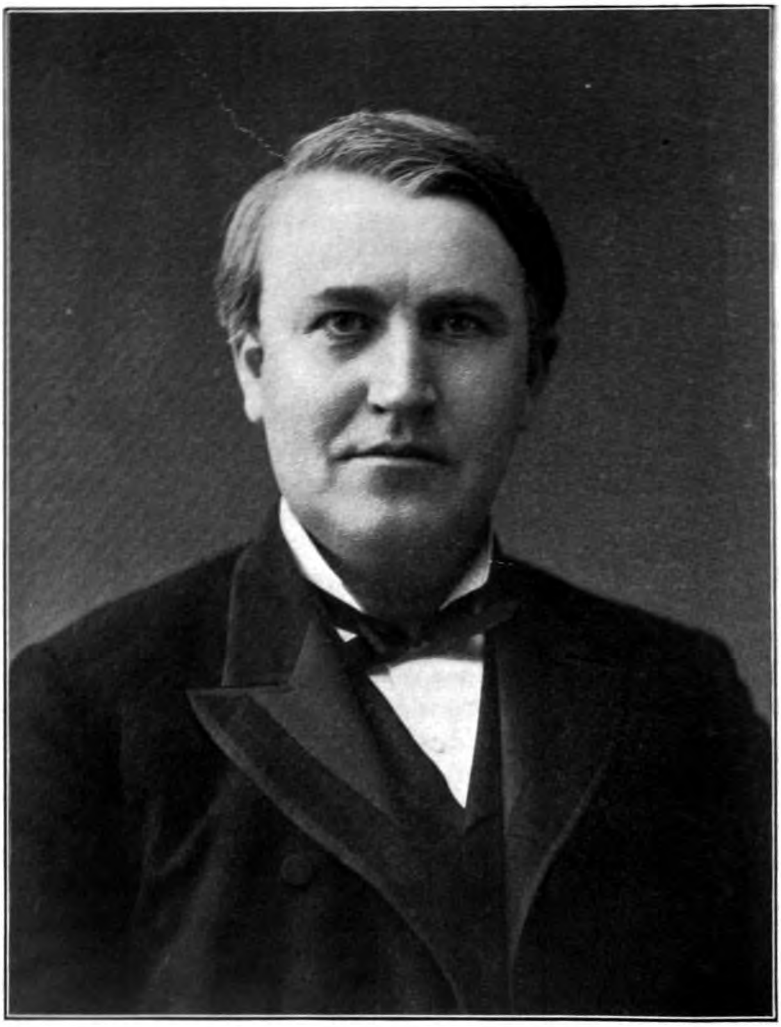
The electric railways of the United States car
enormous total, in round numbers, of *six billion* p
average saving of time per passenger be reckoned a
the annual clear saving of useful time rises to a hu
hour days. Imagine nearly three hundred thousand

playing ten hours per day the year round, and you gain some notion of what the electric railway has done in saving time in the United States alone. But even this by no means tells the whole story of benefits received. The advent of this form of rapid transit, in gaining time of transit, has practically doubled the available areas of cities and towns, and has thus relieved to a very material extent the physical, moral, and pecuniary strains that come from overcrowding. One can hardly estimate the actual value of this work, but it can be seen in growing villages, in workmen's homes, and in healthier recreations the country over.

And aside from this, the immense network of transportation which has grown up is having a powerful influence in breaking down the barriers of isolation in the country districts and in establishing new centers of industry. Every year sees electric traction stretching further out and gaining in speed and facility, so that it is no idle dream to look forward to vastly greater benefits in the future. And here again the transference of the energy supply from stored fuel to the constantly renewed natural sources of energy is a splendid economic result.

In its larger aspects the electric railway is the greatest achievement of electrical progress up to the present time. All the applications of electric motors bear powerfully upon the economy of human energy, many of them directly upon labor saving in the narrower technical sense of that term; but none has had so immediate and vital effect upon the community at large as electric traction.

Very intimately connected with the wider ramifications of electric traction is the art of electrical power transmission, which, like electric lighting, has grown up by a succession of interwoven inventions. No one of these, save perhaps the polyphase system, is pre-eminently responsible for the results that have been achieved, and this is connected alike with lighting, traction, and motive power. But the mere fact that about two million horse power in polyphase generators are in use in the United States is a sufficient indication that the system has at present a dominant value in the electrical transmission of power. The fundamental value of power transmissions lies in the fact that by enabling natural forces to be utilized at any desired place, it enables industrial operations to be carried on at the most advantageous points. It incidentally cheapens power in many regions and tends strongly to equalize economic conditions of manufacture from place to place. Electric traction and electric power transmission between them are capable of increasing many times over the area available for successful industry, thus avoiding the economic waste that comes from unnecessary



THOMAS ALVA EDISON. BORN 1847.

Copyrighted photograph by J. W. White & Co.

Began as a trainboy on the Grand Trunk Railway; learned telegraphy, and became one of the most expert operators in the Western Union Telegraph Company. His remarkable series of inventions began with the duplex telegraph, in 1870, and his work still continues.

transportation both of persons and material. It would be vastly interesting to compute the needless expense entailed by the concentration of industries in large centers of population. People are sometimes inclined to applaud such concentration, as if mere bigness were a virtue; but to see the other side of the question, consider what would be the result of trying to concentrate the cotton manufacture of the United States within the corporate limits of New York city. The only real gain resulting would be to those who profit by the unearned increment of values.

Equalization of the costs of power and of transportation tends to foster the small industries on which local prosperity depends, and this is greatly aided by the transmission of power. And besides calling into action unused water powers, there is an immense possibility of usefulness in the generation and transmission of power from low-grade fuel. Comparatively little is known of the world's resources in inferior coal, lignite, and peat, because the transportation charges have discouraged investigation; but there is good reason to believe that a very large store of energy exists in these unprepossessing forms.

There have been many propositions looking to the electrical transmission of this energy, but for one reason or another very little has practically been done. The growing demand for fuel is bound ere long to push up prices far enough to encourage power transmission from cheap coal, and it very probably may become one of the important factors in the general supply of power.

Up to the present time, however, the utilization of natural powers even has not gone far enough to make a material change in the rate of increase in the fuel demand, so that the great functions of power transmission are largely in the future, in spite of the rapid growth of the art in the last decade. The lesser and secondary effects of power transmission are already much in evidence, in the increasing application of motors to various industrial purposes. Here the effect is seen directly in the saving of labor, and indirectly in the improvement of output due to greater facility in various ways. It seems, for example, fairly well demonstrated that motor driving in textile factories not only reduces expenses by cutting down the net cost of power per machine, but also tends through preservation and accurate adjustment of the most economical speed to enlarge the output per machine. The same tendency appears in print works and in paper mills, and is still more strongly evident in machine shops and engineering works. The modern tendency in these latter cases is to push the output, so as to turn over the investment in plant as rapidly as possible. A planer, for instance, will within its useful life turn off a certain number of tons of chips and it is economy to do this work rapidly. For each operation there is some speed of maximum economy, and one of the most important features of electrical machine driving is the ease with which this speed, if known, can be reached and maintained. This consideration also affects the cost of a given operation in labor, although it does not imply labor saving in quite the same sense as would be evident in changing from hand work to machine work, or in the use of portable motor-driven machine tools.

To the same category as these mechanical uses of electric power belong a group of electrical labor-saving processes, like electrical welding, electrical annealing, and electrical heating for various industrial processes. No single device of this sort is in such extended use as to give it commanding prominence, yet the class as a whole is a large one, responsible for great total gains in the cost of labor, and the number is very rapidly increasing.

Of a far larger importance are some of the striking electrical processes which belong properly to the domain of electrochemistry. The aluminium industry has already risen to large proportions, and the electrolytic preparation of the metal in the electric furnace has quite superseded all other processes. Carborundum, and calcic carbide, the basis of the acetylene light, are also among the chief products of the electric furnace, although the making on a small scale of rubies and diamonds discloses interesting possibilities. Still more sensational is the fixation of atmospheric nitrogen by electrical means, which, while it can hardly yet take rank as a commercial method of preparing nitric acid and nitrates, gives promise of future usefulness and is particularly important because the world's store of nitrates, as a practical mining proposition, is being depleted rather rapidly and its recuperation by organic processes is very slow. On the whole electrochemistry is today the branch of applied electricity in which the most startling developments may reasonably be expected. And these developments are likely to affect profoundly the world's industries.

Late discoveries like the X rays and wireless telegraphy are probably to be of high value to civilization, but they cannot yet claim great industrial importance. The electrical work of the last half-century has told for much in the world's welfare, and will count more rather than less as the years go by. Its relation to the fundamentals of human industry and civilization has been up to the present less far-reaching than its contribution to the complexity of that civilization. In another century its basic value will be better appreciated.

EDITORIAL COMMENT

THERE are some elements of life so all-pervading that through very familiarity we become unconscious of their presence. It is only by the negative method of imagining them away that we find how widely and deeply they are built into our civilization. Thus, as Mr. Hunt effectively says in our leading article "it is bewildering to try to realize that which *would not have taken place* in human progress," had it not been for Bessemer steel.

So it is above all with labor-saving machinery. Taken in its fullest meaning, there is no act of manufacture, no stroke of construction, no detail even of household work, in which at some stage labor-saving machinery does not play a vital part. Sometimes we stop for a moment before a mighty expression such as the Forth Bridge or the 40,000 horse power of a giant liner, and point to it as marking the progress of the age; but every nail that is driven—every needle in the housewife's work basket—every kettle on the range in the workman's cottage—is equally an expression of the stored skill of generation after generation of inventors—metallurgists, mechanicians, engineers. It is the embodied thought of centuries of genius which lightens the toil and betters the life conditions of the living race.

In so vast a domain, the problem is to choose a path that shall give any sufficient idea of the whole. It must be done, if at all, by centering our attention upon the great facts and principles which underlie—by outlining the principal departments and tracing their typical expression—and by studying representative examples which bear the characteristics common to the group. Even this far exceeds the bounds which necessity fixes for a single magazine. This first "Labor-Saving Number" of THE ENGINEERING MAGAZINE must therefore be taken as part only of the proposed review. It is the opening section of a three-fold group. The present issue deals with the foundation of the subject—the use of power to relieve manual labor. It will be followed shortly by two other numbers dealing with two other great phases—"Labor-Saving in Industrial Management," and "Labor-Saving by Mechanical Transport." And all three outline a field and trace a policy which is defined and filled in, in its details and special applications, consistently and constantly, in every regular issue of the Magazine.

* * *

THE lapse of time between the introduction and the perfection of modern inventions seems greatly accelerated over the rate at which some of the great improvements of past centuries were developed. In the other pages of this issue the story of the long years of toil and discouragement which marked the work of many inventors is told; but while these sheets were on the press engineers and scientists were celebrating with the inventor of the incandescent electric lamp the twenty-fifth anniversary of its production. The quarter-century of life which Mr. Edison's invention has covered, and in the greater part of which it has been in full commercial operation, is evidence of the promptness with which modern inventions are exploited and adopted.

The Edison banquet, given in New York by the American Institute of Electrical Engineers, celebrating at the same time the fifty-seventh anniversary of Mr. Edison's birth and the twenty-fifth year of existence of the incandescent lamp, was a notable occasion in the history of applied science. Not only was the room brilliant with the glowing bulbs themselves, but there were also present other examples of the inventive skill of the guest of the feast: the quadruplex telegraph, the gold-stock ticker, the phonograph, models of many ingenious applications of science to industry, and all the developments of a single active life of a man yet in his prime, these rendered the occasion most noteworthy.

* * *

As in the case of the John Fritz dinner of two years ago, the Edison banquet was made the occasion of the foundation of a medal, and most appropriately, the Edison medal is to be awarded annually to the student in electrical engineering whose thesis or recorded research shall be deemed most worthy of honor. No better comment can be made upon this noteworthy foundation than that of Mr. Edison himself, as contained in the message telegraphed by himself from his place at the high table to a receiver in the hall:

> "This medal is founded to encourage young men to devote their best thought and work to electrical development. I rejoice in this stimulus to harder study. Better trained and educated than were we pioneers of the times before every college and university had its electrical course, these coming men of the future should, and I believe will, carry forward to triumphs and arts heretofore undreamed of, the principles and applications of elec- icity to which I have tried humbly to ote my life and energies from the hour hand first touched the key."

Among the many messages of congratulation received at the banquet may be mentioned those from the President of the United States, from the Lord Chief Justice of England, from Lord Kelvin, from Marconi, from Mascart, Kapp, Carnegie, and others too many to enumerate here, and throughout them all the note was that set by the President, who said:

"I congratulate you as one of the Americans to whom America owes much, as one of the men whose life work has tended to give America no small portion of its present position in the international world."

* * *

WITH the ratification of the Panama Treaty the last uncertainty as to the choice of route for the Isthmian waterway disappears. Eight years ago, when THE ENGINEERING MAGAZINE took up the question, the country seemed hopelessly committed to the Nicaragua project. From that mischance, wise counsel and wide enlightenment have saved us. It is the pride of THE ENGINEERING MAGAZINE that these pages have been the medium through which the very greatest of the thinkers and workers upon the problem have addressed the country, and moulded public opinion to a decision in accord with common sense and sound practical judgment.

The successful, prompt, and economical completion of the work now rests with the Commission. As is their wisdom, so will the result be. The selection of Admiral Walker was natural, logical, and fitting, but not all the appointments are so adequate. It is to be most earnestly hoped that the Commission will be supplemented by a chief engineer whose tried experience and proved success in the conduct of great enterprises of this peculiar kind will give the country a sense of assurance upon which it can confidently rest.

REVIEW OF
THE ENGINEERING PRESS.
"THE WORLD IS ITS FIELD"

THE PRODUCTION OF RADIUM.

SOURCES OF RADIOACTIVE MATERIAL AND METHODS OF EXTRACTION OF RADIUM COMPOUNDS OF HIGH ACTIVITY.

Revue Générale des Sciences—Le Génie Civil.

ALTHOUGH much has been written about the curious properties of radium and its compounds, comparatively little information has been made public concerning the preparation of the substance at present attracting so much attention. For this reason the papers of M. Debierne, in the *Revue Générale des Sciences*, and of M. Danne, in *Le Génie Civil* are of interest at the present time, containing, as they do, technical descriptions of the processes involved in the extraction of radioactive substances from the ore in which they are contained.

In order to follow the methods employed, which involve rather great patience and care than any especial appliances or materials, a few words may be said as to the manner in which the existence of radium was discovered. In 1896 M. Becquerel discovered that uranium and its compounds possessed the property of emitting, spontaneously and continuously, although feebly, rays which were capable of acting upon photographic plates, of ionizing gases and rendering them conductors of electricity, and of passing through opaque bodies. Two years later Madame Curie, in France, and Herr Schmidt, in Germany, found that similar properties were possessed by thorium compounds. In studying these new and curious properties of matter Madame Curie found, using the electrical method of examination, that this property of radioactivity was atomic in its character, that is, it was possessed by all the compounds in direct proportion of the quantity of uranium or thorium present. Upon further examination of the mineral pitchblende, from which uranium is principally obtained, however, it appeared that the raw mineral showed a higher degree of radioactivity than was due to the amount of uranium present. This observation led to a series of investigations, involving a process of elimination, the successive constituents of the pitchblende being removed and the remainder examined for radioactivity. The result was the discovery of a minute quantity of material, highly radioactive, and different from uranium, thorium, or any other known substance. By 1900, after long and tedious experiments along these lines, M. and Mme. Curie succeeded in proving the existence of two new elements, a million times more active than uranium; polonium, a substance similar to bismuth, and radium, a material similar to barium. Later M. Debierne has added to these a third radioactive substance, called actinium, and belonging to the group of rare earths.

The radium produced by the Curies has all been extracted from pitchblende brought from Joachimsthal, in Bohemia, and the details of the process are as follows: In the first place all the uranium is removed, this being done at the place where the mineral is found, in order to reduce the bulk to be transported. The crushed pitchblende is roasted with carbonate of soda, the product being then lixiviated with hot water to remove the soluble salts of soda, and then treated with dilute sulphuric acid, the resulting solution containing all the ura

The insoluble residue, formerly, in the manufacture of uranium, having been thrown away as without value, is now most carefully collected, since it contains the radium, its activity, even at this early stage, being four or five times that of pure uranium. This residue consists principally of sulphates of lead and of calcium, silica, alumina, and oxide of iron. There are also found in lesser or greater quantities, nearly all the metals, including copper, bismuth, zinc, cobalt, manganese, nickel, vanadium, antimony, thallium, niobium, tantalum, arsenic, barium, and various rare earths. The radium is distributed through this entire mixture in the form of a sulphate.

The first operation effected upon this residue is a treatment with concentrated hydrochloric acid. The material is strongly affected, a portion passing into solution. This solution contains the polonium and actinium, the first being precipitated by sulphuretted hydrogen, while the latter is found in the hydrates precipitated by ammonia. The radium remains in the insoluble portion, which is first washed with water and then treated with a boiling concentrated solution of carbonate of soda, this operation converting into carbonates the sulphates not attacked by the preceding reaction. The material is again washed very thoroughly with water and treated with dilute hydrochloric acid free from sulphuric acid. The solution contains the radium, together with small portions of polonium and actinium. This is filtered and precipitated with sulphuric acid, giving radioactive sulphate of barium, containing also calcium, lead and iron, together with traces of actinium. A metric ton of residue contains from 10 to 20 kilogrammes of these crude sulphates, having an activity of 30 to 60 times that of pure uranium, this latter having been taken as the standard of comparison of radioactivity.

It is now necessary to purify these sulphates. They are first boiled with a concentrated solution of carbonate of soda, and the carbonates thus obtained are converted into chlorides. The chlorides are then evaporated to dryness and treated with pure concentrated hydrochloric acid. The calcium chloride is almost completely dissolved, while the radioactive barium chloride remains insoluble. The solution contains, therefore, the lime, with a very small proportion of the radium. It may be precipitated by sulphuric acid and reworked with a succeeding operation. The radioactive barium chloride is redissolved in water, and again precipitated by carbonate of soda. The washed carbonates are then treated with hydrobromic acid in order to convert them into bromides.

After this long series of operations there is obtained, from a ton of the original material, from 8 to 10 kilogrammes of radioactive bromide of barium, having an activity of about 60 times that of pure uranium. This bromide is now ready for fractional separation. The bromides are dissolved in distilled water, the solution being brought by boiling to the point of saturation. It is then permitted to crystallize in a covered capsule, there being found fine crystals in the bottom of the capsule, from which the liquid may be removed by decantation. These crystals are found to possess about five times the activity of the bromide in solution. The material is thus divided into two portions, upon which the identical operation is repeated. This gives four new portions, which are further treated, the liquid from the stronger crystals being added to the second set of crystals, these portions having about the same degree of activity. There are thus obtained three portions, which are again subjected to a similar treatment. After each series of operations the saturated solution taken from one portion is added to the crystals of the following, there thus being a double series in progress, one continually increasing in strength and the other growing weaker. In this way various radium compounds, such as the bromide, chloride and nitrate, have been produced, of varying degrees of activity.

Radium bromide has been obtained with an activity of about one million times that of metallic uranium, and it and all the other salts of radium are white in color when first prepared, becoming gradually yellowish and even violet in time. They all emit light in the darkness, especially when dried by heat. Owing to the tendency of the chloride and bromide to absorb moisture from the atmosphere they are kept in sealed tubes.

M. Danne gives some interesting details of the apparatus employed in examining the activity of various salts of radium, and discusses the spectroscopic investigations which have been made, besides proceeding to examine the various phenomena which have been observed, but these are, for the most part fairly well known, and we have therefore abstracted principally the details of the preparation of the material itself. By far the most important researches which are now to be desired are those for the discovery of additional sources of supply of the material to which the methods may be applied, and in view of the great value of the new element there is every reason to believe that the search will be continued vigorously in all parts of the world.

THE INFLUENCE OF ENGINEERING EDUCATION.

TECHNICAL EDUCATION IN RELATION TO THE WORK OF THE UNIVERSITIES OF OXFORD AND CAMBRIDGE.

Dr. John Perry—Nature.

In the course of an address delivered recently by Dr. John Perry before the Ashmolean Natural History Society of Oxfordshire and the Oxford Mathematical Society and published in a recent issue of *Nature*, some very interesting points bearing upon the broad character of modern technical education were brought out, and in view of the fact that both in England and the United States there still exists a tendency to consider a scientific training as rather opposed to liberal culture some abstract of this inspiring address is appropriate at this time.

Speaking at Oxford, before Oxford men, and with a full appreciation of all that the education given by the great universities has done for England, Dr. Perry does not hesitate to say what he thinks of the unfitness of present methods for present needs. Taking Oxford as representing the general character of the work of both universities, he shows that practically all the men who form the great governing class of Great Britain are either educated at Oxford or Cambridge, or have been trained under the influence of Oxford methods.

"When, at an age of from twenty-one to twenty-four a young man enters Parliament or diplomacy, or any of the reserved parts of our public services, his character is formed; all his ways of thinking and his prejudices are on the models most revered in Oxford. His early youth has been influenced by Oxford of the past, his undergraduate ways have influenced and been influenced by Oxford of the present, and his prejudices, kept strong by loving memories, exercise an influence against all changes in Oxford for the future."

Dr. Perry does not fail to see the beauty in the Oxford method of education, especially for the limited number of Oxford men who are real students. For them it is the ideal place for one of the most wonderful educations ever known, a place where they meet every day the great scholars of their age who are also students, where they can obtain the highest kind of an education, that which comes from contact with inspiring and enthusiastic teachers.

At the same time this education is not the education which can fit men for the conduct of affairs at the present day. Oxford was in the forefront of the renaissance movement, and in that brilliant time she did not think it beneath her to take up with the great movement of the day. To-day she is retreating back even from the conceptions of the renaissance and becoming more and more mediæval, and the men she is producing are showing themselves correspondingly unfit to cope with present problems. By far the greater number of Oxford men are not students in the sense of searching out the new truths or fathoming the old ones. Dr. Perry does not quote, although he doubtless well remembers Dean Swift's sarcastic saying about Oxford. "Oxford," said Swift, "is a learned place; because a great many men have taken learning there, and no one was ever known to take any away, and so it has accumulated."

"The world now to be governed is getting more and more complex. Man is utilising the energies of nature in thousands of ways unknown to the ancients. Common people are all getting educated. Where the ancients wondered and trembled, we understand and give orders to nature. The average unit of any population was compelled to be what we now call an unskilled labourer.

"Now our labour is becoming more and more skilled. Are you aware that from one ton of coal there is as much energy, as much actual work, as may be done by forty thousand good labourers in a ten hours' day? Our best steam engines utilise only one-tenth of this energy at the present time. But even now we know that the cost of the most unskilled work done by man is one thousand times the cost of the same work wherever it may be done by the best steam engines. One fact of this kind properly considered is worth many long essays about the effect of the engineer in altering all the character of our civilisation. It is labour that is the true standard of wealth. The steam engine has added incalculably to the wealth of the world. We forget that man is no longer needed for unskilled labour, so that when we use unskilled labour we are using the materials which God has given us in the most inefficient manner possible. Furthermore, it becomes sweated labour, it unduly taxes skilled labour, it starves invention, and it brings up base, ill-fed families."

If the rulers of Great Britain, the men who are to make and to execute her laws are to continue to be the product of her universities it is time to consider the kind of a preparation which these universities are giving them. As Dr. Perry well says: "It is a curious kind of culture which scorns the lessons of history, the study of man in his relations to nature, the study of the enormous new forces which are now affecting the relations of nations to one another. How is a boy to reason about things unknown to him. In the nursery he got mental training through everything he saw, everything he clutched. Oxford took charge of him scholastically at the age of seven, and from that time onward his higher mental powers ceased to grow. His mental equipment suggests the item for bread in Falstaff's famous tavern account."

"And he becomes a ruler of this great nation, his duty during war and peace being that of a scientific administrator. Times of actual war are few and short; in those times the people and property of unprepared nations are destroyed with a rapidity never known in the past. In all old times England was unprepared for war, but this did not then so much matter; in future the nation has not prepared for possible war, by the exercise of the highest scientific faculty, will certainly be destroyed.

"Also the war between nations is quite intense in times of peace. The rulers of nations have to take care that their laws do not destroy industries, that they develop the right sort of education of the people; that the people shall be so educated as to become resourceful, full of initiative and invention, capable of learning from experience, people of character. Again, if our rulers set a fashion of gibing at scientific things, at technical education, for example, through ignorance, it is not unimportant to know that the complete loss of trades like the coal tar industries may be more serious evils than the loss of several campaigns in war used to be. If the Prime Minister, or any other minister, gives an important post to a non-scientific man, it may not be harmful, but sometimes it may be very harmful indeed; it may lead to the appointment of many unscientific men or the disgrace of the scientific men already engaged in some department where science is all important. But the evil is very much more far reaching than one can describe in words. Want of science in the rulers means neglect of scientific education and method throughout the whole country."

Although England has done her share in the development of applied science, she has by no means kept pace with France, Germany, or the United States in the development of her educational institutions.

"It is not the schoolmasters, it is the engineers who have been educating England. The engineer is always thinking of utility, of the value of time, of the fact that a man has only one life in which to do what good it is possible for him to do. So he reads novels and poetry and history; he enjoys painting and music; he travels and sees other people, other nations and their monuments. He cultivates and exercises the whole of his mental and emotional machinery so that he may become more perfect as a student of what Goethe called the living mantle of God.

verybody speaks of how the engineer
reated what is called modern civilisa-
has given luxuries of all kinds to the
st people, has provided engines to do
e slave labour of the world, has given
e and freedom from drudgery, and
es of refinement and high thought and
emotion to the thousands instead of
But few seem to see that the en-
r is educating the imagination and po-
aculty of England. Every unit of the
ation is becoming familiar with scien-
ideas, for he can hardly take a step
ut becoming acquainted with roman-
eam engines and electromotors, with
aphs and telephones and steamships,
drainage and water-works, with rail-
electric tramways and motor-cars.
shop window is filled with the prod-
of engineering enterprise. It is getting
rather difficult for people to have any
in evil spirits and witchcraft, and
is probably the most enormous intel-
l stride that the great body of the
n race has ever made in any half-
ry. It has been made in spite of the
tent opposition of Oxford."
a matter of fact the whole movement
chnical education has been hated and
even feared at Oxford, and yet it has progressed continually, and that largely by the efforts of a few Oxford men who have ventured to break through the limitations which their Oxford training imposed upon them.

"It is not only that Oxford keeps aloof from technical education, but she keeps aloof from the very much greater thing of which this movement is only a symptom, namely, the phenomenon that trade and manufacture are no longer left to themselves as they used to be; they are being organised on scientific lines in all countries. She has always ostentatiously held herself aloof from manufactures and commerce. It is almost incomprehensible that a university aiming at breadth of culture should scorn those things which keep England in her high position, give value to the real estate on which Oxford's own revenues depend, and differentiate Oxford from Beyrout."

The influence of Oxford was at one time supreme over England, and it is still enormous, but it is a matter for Oxford and Oxford men to decide how much longer that influence may continue, and whether it shall work for good or for harm.

THE SPECIFIC HEAT OF STEAM.

ERMINATIONS OF THE RELATION OF THE SPECIFIC HEAT OF SUPERHEATED STEAM TO THE TEMPERATURE

Verein Deutscher Ingenieure.

ITH the increasing applications of
superheated steam to practical serv-
ice there has arisen of late a de-
for more accurate data for use in
necessary computations. The inves-
ons of Regnault, made more than 50
ago have stood the test of continual
ical application marvellously well, and
only when the limits within which he
ed are being exceeded that there has
found any occasion to add to his re-
It is now becoming desirable that
elations of pressure, temperature, and
ne of steam should be experimentally
mined for pressures above 400 pounds
square inch, while experience with
heated steam has convinced engi-
that the value of the specific heat of
, (0.48) given by *him, is too low for*
the high temperatures now under consideration.

In recent issues of the *Zeitschrift des Vereines Deutscher Ingenieure* there are papers by Dr. A. Griessmann upon the total heat of superheated steam, followed by a study of the question of the true value of the specific heat by Professor Weyrauch, these together furnishing the latest experimental and theoretical discussions of this important question. From the nature of the subject it is impracticable to give here more than a general idea of the results which have been obtained, referring the interested reader to the original papers for the diagrams, and for the mathematical analysis.

Dr. Griessmann examines the experiments made in England by Grindley, and compares them with a series conducted with much care by himself. Both series of tests show that the specific heat increases with the temperature, but the experiments of Griessmann indicate that the rate of increase is less rapid than given by the results of Grindley, and since the tests of the latter at the higher temperature show a tendency to approach those of Griessman, it may be that a closer accord would follow a renewed investigation.

Thus, according to Dr. Griessmann the specific heat at 130° C. is about 0.48, while at 150° C. it is 0.55, and at 160° C. it reaches 0.60; following very nearly a straight line law. Grindley, however, gives a value of 0.52 for 130° C., and reaches 0.63 for a temperature of 150° C. In view of the fact that the experiments of Griessmann are more numerous than those of Grindley, and that they show a substantial agreement with each other, it is probable that his values are more nearly correct than the higher ones.

Professor Weyrauch is inclined to accept still lower values, taking, in his computations, the formula of Regnault with the constants derived by Hirn: $c = 0.43 + 0.000378\,t$, in which c is the specific heat at constant pressure, and t is the temperature in degrees centigrade. This gives, for a temperature of 160° C. a value for c of 0.49, which is so much below either Grindley or Griessmann as to be received with hesitation. Although Griessmann gives no formula to represent his experiments, his results are very closely reproduced by the expression: $c = 0.375 + 0.00375\ (t - 100)$ in which the values of c and t are the same as before, the expression $(t - 100)$ corresponding to the excess in temperature of the steam above the boiling point.

These later results agree very fairly with those deduced by Professor Bach several years ago, and also with the theoretical investigations of M. Delaporte, reviewed in these columns last month.

With this substantial agreement between experiment and theory this important question must be allowed to rest until further investigations add to the fundamental data upon which a rational formula may be based.

MECHANICAL ROAD TRACTION.

THE RENARD SYSTEM OF AUTOMOBILE TRAINS WITH MULTIPLE PROPULSION FOR THE TRANSPORT OF MERCHANDISE OVER HIGHWAYS.

Le Génie Civil.

ALTHOUGH by far the greater portion of the attention which has been given to motor vehicles has been directed to the production of pleasure, racing, and touring automobiles, this phase of the subject must necessarily subside to a certain extent and the more practical problems of transport be treated scientifically. Automobile trucks, lurries, delivery wagons, and the like have been designed, and many of these have proved themselves efficient and convenient, but their limited capacity has prevented their use for the cheap transport of merchandise in quantity over considerable distances. Attempts have been made to provide a powerful machine, hauling several trailers, and although some success has been attained in France in this way by Scotte, the difficulty in controlling and manœuvring such trains on the highway has prevented their general use.

A modification of the train system is that which has been devised by Col. Renard, and from a description of his system in a paper by Col. Espitallier, in a recent issue of *Le Génie Civil* some account of the method is taken.

The principle involved in the system of Col. Renard is that of making each member of the train self-propelling, the motor vehicle at the head being simply a portable generating station from which the energy is distributed to all the vehicles. With this is included an automatic system of steering, by means of which the members of the train all track the same, in such a manner that if the motor vehicle is run in sand all the other vehicles of the train will pass in its tracks, regardless of the curvature or irregularity of the course.

The principle employed in the Renard system is by no means new, having been employed for railway traction by W. H. James in England as long ago as 1823. Its use on highways, however, is the main feature under present consideration, and for this purpose it possesses many advantages. Briefly the method consists in the use of a continuous line of shafting, driven by the motor on the power vehicle, the trailers being connected by short sections of shaft with double universal joints. By using the well-known arrangement of two universal joints the angular speed variation is obviated, and the rotation of the motor is transferred smoothly to each vehicle. The main line of shafting runs through the entire train, which may contain as many vehicles as may be necessary, each taking its power from the shaft by bevel gears, and all thus being propelled at the same speed.

Each vehicle has its front wheels fitted with the Ackermann arrangement of steering levers, and these levers have a short tongue forming the connection to the preceding car. As each car is deviated from its path it turns the connection to the next, this turning the steering wheels to the proper angle, and causing all the cars in the train to follow the path of the forward motor car.

The arrangement forms a combination of which the tractive power is limited only by the power of the motor, and all the difficulties involved in the haulage of a train by the adhesion of a few wheels to the road are avoided. If one vehicle encounters a bad place in the road the adhesion of the remaining cars will generally be found sufficient to pull it through, while the combined tractive power of the whole train enables grades to be surmounted which would be altogether impracticable for a single traction engine and train.

The rigidity which might otherwise be found objectionable in such a mechanical connection through an entire train is obviated by the use of spring compensating devices placed in the connection between the main shaft and the driven axles. In the trains with which recent experiments have been made in France this spring connection is placed in the hub of each driven wheel, in the form of a spiral band spring, making an elastic connection between the wheel and its shaft; a plan which has been found to work well in actual service.

Experiments with trains of the Renard type, using steam and gasoline motor vehicles, have shown that trains of eight to ten vehicles can be propelled along highways at speeds of 4 to 18 kilometres per hour, according to the grades, while trains with four cars make speeds of 8 to 36 kilometres, the motor itself being capable of a speed of 72 kilometres. In all cases the trains have showed themselves to be under perfect control, turns of short radius being made with ease, and grades as steep as 10 per cent. being surmounted.

The practical applications of this system will be seen to be numerous and important. As originally planned by Col. Renard, it is intended to provide mechanical propulsion for army trains, and for this purpose it offers numerous advantages. Heavy military automobiles are necessary of limited use in difficult country, while their carrying capacity is limited. Experience with ordinary traction engines hauling wagon trains has been discouraging, because of the difficulty in controlling the train, and the insufficient adhesion of the single machine. With a multiple driven train the main power vehicle need not be of excessive weight, while the distribution of the weight and power of the whole over an extended length enables headway to be made where it would otherwise be impossible.

Apart from the applications of the method to military purposes it is quite possible that such a system of merchandise transport upon ordinary highways may prove a valuable auxiliary to the work of steam railways. There are many districts which could be brought into connection with railway stations and thus developed if feeder lines of road transport were established, and the ability to make up trains along the road, and deliver these to the neighboring railway might build up important additions to the traffic of a system.

In this connection it is interesting to note that a similar system of highway train transport has been developed in the United States. The Gibbs system, however, operates by the use of electric instead of mechanical transmission between the vehicles, with separate electric motors on each vehicle, a gasoline engine and a dynamo being carried on the tractor. There is undoubted room for both systems, and the success of either depends mainly upon the provision of suitable roads to permit the use of mechanical traction with reasonable convenience.

THE SINGLE-PHASE RAILWAY MOTOR.

THE LATEST DEVELOPMENTS OF THE ALTERNATING-CURRENT ELECTRIC MOTOR FOR RAILWAY SERVICE.

American Institute of Electrical Engineers.

IN the tremendous development of electric railways, the direct-current motor has been almost universally employed, and the close study and hard work that have been given to it have resulted in the evolution of a machine which is admirably adapted to its environment. It is efficient, simple, easily regulated, and has been brought down to small compass and weight. In itself and in its controlling apparatus it leaves little to be reasonably desired, and as long as electric railways were confined within a limited area there was small demand for anything better.

But with the growth of interurban railways and the application of electricity to the operation of long-distance standard roads, the question of the distribution of current has come to the front, and becomes more and more insistent the longer the line. This question has been answered indirectly by transmitting high-tension alternating currents from some power station conveniently situated to rotary-converter substations and there converting them to direct current of moderate voltage for the motors.

Another solution of the problem has been by the use of polyphase motors, fed directly, or through a transformer on the car, with current from the line. Among the notable examples of this class of road are the Valtellina railway in Italy and that between Burgdorf and Thun in Switzerland.

The polyphase system, however, has several inherent disadvantages, among which are the necessity for having three line conductors, or two and the return through rails and ground, the inefficient operation of the motors except at certain critical speeds, and the complicated controlling apparatus, involving liquid rheostats and other troublesome parts.

All these considerations have forced upon electrical engineers the necessity of designing a single-phase alternating-current motor which shall meet the modern requirements of railway work. Such a motor must be able to start under a heavy load with a reasonable consumption of energy, and should possess a high efficiency over a wide range of speed. Patient investigation and many trials have shown that the single-phase motors which best fulfill these conditions have commutators on the armature, or rotating member, and are in many respects similar to ordinary direct-current series-wound motors, but with laminated iron in the fields to avoid excessive loss from eddy currents, and with special precautions to prevent sparking at the brushes. The commutator type of single-phase series motor may be divided into two main clases, in one of which the primary current traverses both the field and the armature, and in the other of which the armature forms a secondary circuit, closed upon itself, currents being induced therein by a primary winding which may be part of the field.

Within the past year or so the different kinds of commutator single-phase motors have been developed to the point of commercial usefulness, and at a recent meeting of the American Institute of Electrical Engineers they formed the subject of discussion, one of the types, the so-called repulsion motor, being particularly treated in two papers, one by Mr. Charles P. Steinmetz, on "The Alternating-Current Railway Motor," and the other by Mr. Walter I. Slichter, on "Speed-Torque Characteristics of the Single-Phase Repulsion Motor."

The repulsion motor has what is very much like a regular direct-current armature in an induction-motor field. "The resemblance to the induction motor is carried still further in that there is no electrical connection between the primary and secondary. This makes it possible to wind the primary for a high line voltage, while the voltage of the secondary winding is chosen at such a value as may be commutated satisfactorily, since it is short-circuited on itself through its brushes.

"The motor has the same characteristics as the direct-current series motor; namely, maximum torque at starting, increasing torque with increasing current and decreasing speed, and comparatively constant efciency through a wide range of speed. The maximum speed of the motor is limited only by the load and impressed voltage, and has no relation to the synchronous speed.

"Owing to the reactance of the motor circuits, the power factor at starting is low and will be so with any alternating-current motor; but in the repulsion motor a low power factor does not mean small torque. On the contrary, the maximum torque occurs simultaneously with the lowest power factor; that is, at starting. The power factor of the repulsion motor rises very rapidly with the speed; it reaches a good value at one-third synchronous speed, and values near to 90 per cent. are obtained over a considerable range of speed. For this reason a large number of poles is not necessary and frequencies of 25, 40, and even 60 cycles may be employed.

"The rotating conductors of the secondary cutting the primary flux, generate a leading electromotive force, which causes a leading current to flow therein and gives the high power factor of the motor. In the plain repulsion motor, this leading current never reaches a value great enough to compensate entirely for the magnetizing and other wattless currents at available speeds, but the phenomenon is utilized to obtain unity power factor in the compensated type by the addition of a second circuit. The inherently good power factor of the repulsion motor makes it possible to use larger clearance between field and armature than is permitted in induction motors, thus greatly increasing its value in railway work where comparatively large air gaps are necessary.

"The efficiency while not so high as in a direct-current motor, is yet very good, reaching values of from 80 to 85 per cent., including gear loss, for sizes ranging from 50 to 200 horse power.

"Commutation at normal speeds is inherently good, owing to the revolving field. As the speed decreases, the current increases rapidly, producing a tendency to spark, but with the reduced voltage of starting the rush of current is limited to values within the range of good commutation, as in the direct current motor.

"At higher speeds, ranging above one-and-a-half times synchronism, the frequency of commutation becomes high and sparking appears."

Mr. Steinmetz called attention to the early work of Rudolph Eickemeyer, of Yonkers, "who was far-sighted enough to realize the absolute necessity of the series-motor characteristic for railway work, and to undertake the development of the single-phase alternating-current series motor.

"As was pointed out by Gisbert Kapp, the power factor of the alternating-current series motor is inherently low, since the same magnetic flux which induces, proportional to the frequency of rotation, the electromotive force of useful work in the armature conductors induces in the field coils an electromotive force of self induction, proportional to the frequency of alternation, thereby giving the armature the same number of turns as the field (which is more than is permissible in good practice, since that requires weak armature and strong field). Even at synchronous speed the electromotive force of rotation of the armature would still only be equal to the electromotive force of self induction of the field; and the power factor, allowing for an additional self-induction of the armature, would be below 70 per cent.

"Eickemeyer solved this difficulty by designing the armature with a number of turns several times greater than the field (24 to 7 in the first motor built), and neutralizing the armature self induction and reaction by a stationary secondary circuit surrounding the armature at right angles electrically to the field circuit, and either shirt-circuited upon itself or energized by the main current in opposite direction to the current in the armature."

Several motors of this type were built and tested, with fair results, but at that time, 1891 and 1892, the high frequencies used in standard practice militated against success.

"Instead of closing the stationary circuit upon itself as secondary circuit and feeding the main current into the rotating armature as primary circuit, mechanically the same results would obviously be obtained by using the stationary circuit as primary energized by the main current and closing the armature upon itself as secondary by short circuiting the brushes and thereby keeping the main current and the line potential away from the armature. This introduces the great advantage of reversing the sign of the uncompensated part of the armature sel induction, so that it is subtractive, which results in an essential improvement of the power factor, especially at low speed.

"This motor, then, consists of a short-circuited armature surrounded by two coils at right angles with each other and connected in series, the one parallel to the effective armature circuit, acting as primary of a transformer to induce the secondary armature current; the other being the field exciting coil. The ratio of turns of these coils is the ratio of effective armature series turns to field turns, as discussed before. Obviously, these two coils can be replaced by one coil at an angle with the position of brushes, and the cotangent of the angle which the axis of this coil makes with the position of the brushes is the above ratio; that is, the smaller this angle the greater is the ratio of armature to field turns; that is, the better the power factor of the motor."

Such a design as this last constitutes Professor Elihu Thomson's repulsion motor.

Mr. Slichter exhibited curve sheets showing the characteristics of some of these repulsion motors. One of the sheets gave curves "taken from tests on a 60-horse-power, 25-cycle, 500-volt motor, which show the rapidly rising efficiency and power factor and the large torque at starting. The starting torque is 2,300 foot pounds, with an input of 325 amperes, and the normal torque during acceleration, 450 foot pounds at 750 revolutions and 125 amperes. Thus the starting torque is 5 times normal and the starting current 2.6 times normal; or the torque per ampere at starting is 1.92 times what it is at normal speed, should occasion demand the full starting capacity of the motor. .

"This gives an idea of the steep speed-characteristics of the motor, which are even better shown in another sheet comparing the speed and torque curves of a repulsion motor and a standard direct-current series railway motor. This shows that the torque increases more rapidly with increasing current in the repulsion motor than in the direct-current; and, conversely, that the speed of the repulsion motor increases more rapidly with decreasing current than in the direct-current motor. Efficiency, including gear loss, is 84.5 per cent. at the maximum for the alternating-current motor.

"The characteristics show the repulsion motor to be admirably adapted for acceleration work, the efficiency of acceleration being higher than in direct-current work, due to the possibility of obtaining fractional electromotive forces with alternating currents without introducing the dead resistance losses of the direct-current system of control."

This is shown on a third sheet, which gives the acceleration curves from a test of a 25-ton car equipped with two 60-horse-power repulsion motors, and corresponding curves calculated for a direct-current equipment.

"The gearing is chosen for the same free running speed, 33 miles per hour, the same average acceleration, and the same distance covered in sixty seconds. For the direct-current motor the curve of kilowatts input, miles per hour, and miles traveled, are given as calculated; and for the alternating-current motor, the kilovolt-ampere input, kilowatt input, miles per hour, and miles traveled, from test.

"The repulsion motor remains on the controller only 16 seconds and the direct-current motor 25 seconds. The maximum power taken by the direct-current motor is 70 kilowatts and by the repulsion motor 61 kilowatts or 67 kilovolt-amperes. At the end of 25 seconds, the total kilowatt-hour input in the two cases is .375 for the direct-current and .30 for the alternating-current car. At the end of 60 seconds both cars have covered a distance of .039 mile and have reached practically the same speed of 32.5 miles per hour, the kilowatt-hour input being .72 for the direct-current and .685 for the alternating-current car.

"By comparing the areas of the kilowatt curves in the two cases the gain, or rather the saving, by the use of the alternating current is readily seen. It is also worthy of note that the volt-ampere input of the alternating-current motor is least at starting: that is, the line current is least. As this is the time at which the power factor is lowest, it is seen that the effect of the low power factor on the regulation of the system is much modified by the small value of the current.

"A fourth curve sheet shows the calculated characteristics of a 175-horse-power railway repulsion motor having an air gap of .15 inch and wound for 1,500 volts and 25 cycles. The efficiency, including gear loss, is 85 per cent. at the maximum, and the power factor is 93. Such a motor is designed for heavy, slow-speed locomotive work, which is probably one of the most promising fields for the alternating-current motor. It is readily seen how well it is adapted for freight haulage by the fact that the efficiency of 85 per cent. is attained at a speed as low as 500 revolutions, thus permitting a speed of 12 to 15 miles per hour, with a good gear reduction."

In answer to questions, Mr. Slichter said that so far the largest motors which his company had placed on standard car trucks with 36-inch wheels did not exceed 100 horse power, but it is understood that progress in this direction, as in others, is being made all the time; and in the course of the discussion Mr. B. G. Lamme stated that he had been able to instal 150-horse-power single-phase motors on trucks with 36-inch wheels, and had even been able to squeeze them onto 33-inch wheel trucks, and that he expected soon to do the same with 200-horse-power motors.

The discussion also brought out the statements that the single-phase motors at present weigh a little more than the direct-current machines of the same power, but that there is every expectation that the weight of the alternating-current motor will be reduced when it receives as much general attention as has been given to the direct-current types. The weight of the controlling apparatus for both kinds of motor is said to be about the same.

From all the facts elicited at the meeting under review, and from other information of work along similar lines in Europe, it may safely be stated that the long-desired single-phase railway motor has arrived.

THE HEAT TREATMENT OF STEEL.

SIXTH REPORT OF THE ALLOYS RESEARCH COMMITTEE UPON THE BEHAVIOUR OF ALLOYS OF CARBON AND IRON.

Institution of Mechanical Engineers.

AMONG the valuable investigations conducted by the Institution of Mechanical Engineers the successive reports upon alloys have held a high place, and the appearance of the sixth, and last of the present series demands careful attention and review. In some sense these reports form a memorial to the late Sir W. C. Roberts-Austen, since the important share which he took in the investigations upon which they are based has been well known, and the fact that the present report is the only posthumous work of his rendered its appearance an occasion for some worthy tributes to his memory. The report, although blocked out by Sir William Roberts-Austen, is practically the work of Professor William Gowland, assisted by Mr. Merrett, Mr. Harbord, and others, to whom full credit should be given.

The sixth report practically forms a supplement to the fifth report, continuing the subject of steel, considered as an alloy of iron and carbon and of other minor constituents, and is devoted entirely to the effects of heat treatment upon test specimens of different chemical compositions. The tests were made upon steel of eight different compositions, each variety being subjected to twenty different kinds of heat treatment, thus giving 160 variations, the effects being examined by mechanical and metallographical examination, this plan being devised to enable comparative data to be secured for future study.

In his introduction Sir W. Roberts-Austen emphasises the vital importance of the consideration of the phenomenon of allotropy in connection with the study of the properties of steel. The allotropic changes in the iron itself are all important factors in determining the relations between iron and carbon which are involved in the characteristic capacity of steel for being hardened and tempered. The question of annealing is included in the work discussed in the report, the definition of annealing adopted being that of Sauveur as the operation of rendering the quenched metal "as soft, tough, and ductile as possible, by decreasing the elastic limit and tensile strength only by such abnormal increments as were acquired by hardening and cold working." The annealing of the test specimens under consideration was effected by maintaining the steel at a temperature ranging between 625° C. and 1,100° C., followed by a more or less prolonged cooling.

In connection with the investigations upon annealing a portion of the report is devoted to a study of the effects of "soaking," or the exposure to heat for a prolonged period. This has been effected by examining the properties of specimens which have been heated to definite temperatures for twelve hours, with the result of showing very definitely the changes which this operation is capable of effecting.

The third portion of the report is devoted to a discussion of experiments upon hardening, this effect being produced by causing a portion of iron carbide to be dissolved in the iron and a reversion to the soft condition being prevented by the rapid abstraction of heat.

The report is therefore divided into three parts, treating successively of annealing, soaking, and hardening, each of these being discussed with the aid of tables diagrams, and microphotographs. Its voluminous character prevents anything but a general review of the results here, while reference to the original will enable detailed information to be gathered from the tables and other records. The report is a noteworthy example of the extent to which the new science of metallography is coming into practical service, and the microphotographs are very fine examples of the work of the microscope and the camera.

One of the most important results of the annealing experiments is the confirmation which they give of the effect of moderate temperatures, a heat of 620° C. having a perceptible effect in increasing the elongation. The continuation of the annealing experiments show that a temperature of about 900° C. gives the best results, the bars heated to this temperature for half an hour showing practically a complete solution of the various constituents, permitting rearrangements to take place according to the rate of cooling.

Under these conditions the maximum strength is obtained, as well as a material increase in elongation under test, while if this temperature is greatly exceeded the material is liable to become burnt.

Passing to the soaking experiments, in which a period of twelve hours instead of half an hour was given to the heating of the specimens, it appears that the increase in the duration of application of heat has a marked influence upon the material. The effect upon bars soaked at a temperature of 620° C. was to reduce both the breaking strength and the elastic limit, but to increase the elongation very materially over that of bars heated only half an hour. At the higher temperatures no material difference was shown for the soaked bars over the annealed specimens, except for the bars containing 1.3 per cent. of carbon, which, when soaked for twelve hours, showed a greatly increased degree of elongation.

The most important conclusion drawn from the results of the soaking experiments is the possible availability of the process for the production of metal suitable for the construction of gun tubes.

The present method of producing large ingots of gun steel is by quenching in oil and subsequent annealing, but with pieces of large size it is but with pieces of large size it is difficult to secure uniformity by this process. By an examination of the experiments, however, it appears that the necessary mechanical properties for the construction of ordnance have been obtained in soaked and slowly cooled low carbon "special" steels. It also appears possible to use an ordinary "soaked" carbon steel for this purpose, so that the researches of the committee in this direction may prove of great value in connection with ordnance construction.

The experiments upon hardening contain results obtained by heating the specimens to temperatures from 720° C. to 1,000° C. and quenching them in various cooling liquids. Since this process is one frequently used in the arts, and one concerning which many discussions have been held, and numerous nostrums advocated, some of the remarks about it are of interest. Within certain limits, the more rapidly the heat is abstracted the more effective will be the hardening. The bath must be large enough to have its temperature but slightly affected during the quenching of the metal, otherwise the hardening will not be uniform. In the tests discussed in the report water was used, and also oil, the results being very fully tabulated and illustrated. The relation of the hardening temperature to the carbon content and to the general composition is clearly shown, and the results should be of material value in connection with practical operations of this sort.

The whole report is a most valuable contribution to the applied science of engineering, and the Institution is to be congratulated upon the success of the work of the committee which it has appointed and maintained. It is just such work as this which removes "practice" from the domain of empiricism and relieves theory from the imputation of impracticability. When all the fundamental operations and methods of engineering are subjected to such judicial investigation and study the opportunities for quackery in applied science will be vastly diminished, and the progress of civilization correspondingly aided.

ELECTRICAL STATISTICS IN GERMANY.

TABULAR REVIEW OF THE DEVELOPMENT OF CENTRAL ELECTRIC GENERATING STATIONS IN THE GERMAN EMPIRE.

Elektrotechnische Zeitschrift.

In a recent issue of the *Elektrotechnische Zeitschrift* appears the regular annual review of the growth of the production of electricity in the empire, from which we abstract some data of interest. The report is very complete, the various cities being arranged in alphabetical order, followed by columns giving the population, the electric system employed, kind of motive power, capacity in kilowatts, etc. As in the case of previous reports, the data relate only to generating stations which distribute electrical energy for general public use and for sale, with the exception that some large private plants from which current is delivered to operative departments at a distance are included, these practically constituting central stations as important as some of the public plants. The statistics are brought down to April 1, 1903, and are thus comparable with those for the same period in previous years.

There are at present in Germany 939 electric stations coming within the above classification, to which may be added 95 others in course of construction, some of which are doubtless in operation at this date. Of these 939 stations there are 50 having outputs of more than 2,000 kilowatts, these being distributed among 37 cities, and their total capacity being 271,479 kilowatts. The largest stations are naturally to be found in Berlin, where the Moabit station represents 26,523 kilowatts and the Oberspree station, 25,425 kilowatts. Berlin has also a number of other electric generating stations, the total output being 75,600 kilowatts. The great hydro-electric station at Rheinfelden is credited with 12,600 kilowatts, while Munich, Frankfurt, Hamburg, and the other large cities follow close behind.

In comparison with the previous year a material advance appears. The total number of stations in the report for 1902 was 870, as against 939 for 1903. In 1902 the number of incandescent lamps supplied was 4,200,203 and in 1903 this had risen to 5,050,584; while the number of arc lamps had increased from 192,059 to 218,953.

Although many of the stations included in the list are used for local service there are some which extend their distribution over a wider area. Thus the works at Brühl, near Cologne, delivers current for lighting and power to 66 establishments within a radius of 15 to 20 kilometres, while the Upper Silesian Works supplies current to the entire surrounding manufacturing district. The hydro-electric station at Rheinfelden delivers electrical energy to 46 distinct points, while the Neckar Works supplies 40 establishments.

An important feature in connection with the distribution of electrical energy over an industrial district is found in the application to household manufacturing, the small consumer being able, by reason of convenient available power supply, to compete with the large factories. An example of this phase of the question is seen in the case of the Anrath works near Crefeld, in which the greater part of the current generated is consumed in operating motors of ¼ to ½ horse power for driving the silk ribbon looms in the houses of the independent operatives.

The publication of these statistics affords a most interesting view of the growth of the electrical industry in Germany, and a comparison of the present figures with those of previous years is instructive. Thus in 1894 there were but 148 stations in the empire, and the growth at first was but gradual. By 1899, however, the increase was more rapid, the figure advancing from 489 stations in 1899 to 652 in 1900, and, as already noted, reaching a total of 939 generating stations, exclusive of isolated plants, in 1903. The increase in output, however, has been far greater, since the later stations include the much larger modern plants. Thus the increase in number of stations has been 631 per cent., while the number of incandescent lamps has grown from 493,801 to 5,050,584, or more than 1,000 per cent., and the horse power of motors supplied has increased from 5,635 h. p. in 1894 to 218,953 h. p. in 1903, or nearly 4,000 per cent.!

With the increasing development of the industry there has naturally appeared an increasing difficulty in obtaining full and complete statistics of the various works, but the information is well worth all it costs, and it is to be hoped that the desirability of keeping such a full and complete record will appeal to the producers as well as the consumers of electric current, and also to the manufacturers of electrical machinery, and that full data and information will be freely furnished for the purpose of disseminating reliable data.

GAS ENGINES IN RAILROAD WORK.

APPLICATIONS OF THE INTERNAL-COMBUSTION MOTOR IN RAILWAY SHOPS, YARDS, AND PUMPING STATIONS.

Prof. W. T. Magruder—Central Railway Club.

DIFFERENT kinds of motive power machines have their applications for various purposes, and the influences which control the choice are not those always which are most apparent at first. The claims for the gas engine, or more broadly, for the internal-combustion motor, are generally based on its high economy, but there are other reasons which are sometimes of greater importance. In discussing the use of gas engines in railroad work, Professor W. T. Magruder, in a paper recently presented before the Central Railway Club, examines the various reasons for the extended use of the gas engine in various departments of railway plant, and some abstract of his paper is given as indicating the importance of the subject.

The earliest use of the gas engine in railway service was in connection with pumping stations, especially for isolated points where skilled attention could be given only intermittently. Such engines may be started in the morning by the station agent, or by a track walker, and left running until stopped by an automatic appliance when the tank is filled, or stopped by the same attendant at the end of the day. Using gasoline as fuel such engines have come into extensive use in the central and western states of America, and although primarily introduced for reasons of convenience they have also been found extremely economical.

As Professor Magruder points out, however, such gas-engine pumping plants have been used almost entirely for small installations the opinion prevailing among railroad men that steam is preferable for larger plants. The development of the large gas engine, however, is extending to railway service, and in some instances a gas electric power system has been introduced, the power being transmitted electrically to pumps at a distance.

"If the plant is such a large one that the services of a pumper are constantly needed, then a cheaper fuel than gasoline should be used, and either a suction gas producer or an oil gas producer should be installed. By this means the total cost of operation can be reduced by the difference in the cost per horsepower of the coal used in a boiler, and the coal or oil used in a producer. It is not considered wise to allow the gasoline plant to be without attention for over four or five hours at a time, as the delay to train service by lack of water at the pumping station due to a break-down of the gasoline engine or pump would be more costly to the company than the services of a pumper for many days. It should be borne in mind, however, that there are certain spare parts which every gasoline pumping station should always have at hand, such as extra battery parts, ignition points, springs and lubricating devices, just as there should be extra or spare parts at a steam pumping plant for use in case of sudden break-downs. Many vexatious and expensive repairs can be prevented by the installation of an engine and pump of high grade. In this, as in many other lines of industry, the machine lowest in first cost is not necessarily the cheapest. A certain number of parts are necessary to every engine or machine, and the builder who saves the purchaser the expense of a few dollars by omitting these parts frequently causes him to spend several times the amount so saved in extra fuel required and in more frequent repairs. On the other hand, the best engine does not necessarily have to have an excessive number of parts, and usually such an engine is liable to easily get out of order. Each part of a gas engine or other machine should have a definite object for its existence, and a definite duty to perform, for which it should be suitable in both strength and material. If continuity of service is desired in a railroad pumping station, it may not be necessary to install an engine such as is required for generating of electricity; but, on the other hand, to install one of the type of engines usually found in the oil fields would be the height of folly, as their construction and finish is usually such that their life is short and directly proportional to their first cost as compared with other engines, while their fuel consumption may be outrageously high. This last is a point of little moment in the case of a pumping engine in the oil fields, using a surplus of fuel, but it is one which cannot be overlooked where the fuel has to be transported and handled several times, as in railroad work. For railroad work, the best machine in use is a good serviceable engine of sufficient weight, run at a piston speed preferably of 500 f. p. m., and not to exceed 600 f. p. m. with electric ignition, and the hit-or-miss system of governing.

The installation of a gas power plant at a railway station will be accompanied by numerous opportunities for the replacement of hand labor by power. Thus turntables are readily operated by electric motors, while coal handling, rock crushing and the like are conveniently done. The operation of swing or drawbridges may be greatly facilitated by an available source of power, and numerous local applications will suggest themselves.

The success of internal-combustion motors for propelling automobile vehicles has suggested their application to motor and inspection cars, and such machines are coming into general use.

"Such cars really consist of a gasoline automobile running on railroad rails. They are much speedier, and if time has any value, are much more economical than human labor in propelling the car, tools and men. They are usually fitted with air-cooled motors, so that the water-jacketing of the cylinder, with its attending troubles and inconveniences and the necessity for transporting a tank of water are all eliminated. These cars seem to be giving the best satisfaction and it is stated that 'one of them recently completed a bridge inspection trip of 1,500 miles, carrying four men and inspection tools, and made the trip on 45½ gal. of gasoline, making frequent stops to inspect bridges and culverts along the line, and attaining a speed of 25 miles an hour.' This is a fuel consumption of three gallons of gasoline per 100 miles."

In addition to any special applications, there is every reason to believe that the gas engine is well adapted for use in connection with central power stations and railroad shops. Here the fuel economy plays an important part, since modern gas engines fairly rival the steam engine in running qualities, while a gas engine of medium size is as economical of fuel as the largest and most completely equipped triple expansion steam engine.

"Some of the advantages of the gas engine for central stations are: Minimum fuel consumption; low cost of operation and maintenance; simplicity of equipment: only two auxiliaries required, namely, an air compressor for starting the engine and a magneto, or dynamo, for producing current for electric ignition; quick starting; no 'standby' losses; the light load efficiency is superior to that of the steam engine; the waste heat of the jacket water and of the exhaust gases can be used for heating buildings; no danger from explosion; energy can be stored during light loads in one or more gas holders at less cost than by any other means; the greatest efficiency does not demand the use of the largest possible units, and hence the subdivision of the power among a number of smalled units gives better economy. For railroad work it is possible to erect either coal-gas or water-gas producers and to use the product in gas engines for the generating electricity, either at central stations or at different points around the shops and yards. The water gas could be carburetted for illuminating purposes, if desirable. The railroads might be able, in the light of recent experiments and experiences, to convince the managers of city gas-light works that it was to their interest to increase the amount of coal gasified in their present works so as to furnish more gas for use in gas engines by the railroad company and at a rate which would make the net cost of power when so generated much less than with steam power."

RAILWAY CONSTRUCTION IN SWITZERLAND.

THE COMPLETION OF THE NEW RAILWAYS IN THE RHAETICON AND ENGADINE DISTRICTS OF SWITZERLAND.

Bulletin Technique de la Suisse Romande.

DURING the past few years there has been completed in that charming portion of Switzerland known as the Engadine some very interesting pieces of narrow-gauge railway construction, involving engineering feats of direct and helical tunneling, bridge construction, and location of a high order. A very complete account of this work is given in an article by M. F. Rey, in a recent issue of the *Bulletin Technique de la Suisse Romande,* with topographical maps, profiles, and tunnel sections, as well as handsome photographs of some of the more picturesque portions.

The Rhaeticon railway system includes several roads of 1 metre gauge, none of these being long, but all of them possessing features of interest for the engineer. The Landquart-Davos line, of 50 kilometres in length, is the oldest of these, followed by the Landquart-Thusis line, 41.18 kilometres long, the Reichenau-Ilanz line, 19.4 kilometres long, and the Thusis-St. Moritz line, 61.7 kilometres in length.

The latest and most important of these lines is the one connecting Thusis with St. Moritz, popularly known as the Albula railway from the fact that it traverses the Albula Pass by an important tunnel, and also called the Engadine railway because of the convenient access which it gives to that district from Coire and from the entire northern portion of Switzerland.

The line starts from Thusis at an elevation of 700.5 metres above sea level, and attains its highest elevation in the middle of the Albula tunnel at 1823.4 metres, a difference of level of 1123 metres. The earlier portion of the road follows up the valley of the Rhine, diverting from thence to the course of the Albula, which it follows, with frequent crossings, viaducts and tunnels until the crest is reached. In many respects this line resembles on a small scale the St. Gothard railway, making the ascent in several instances by means of helical tunnels in the heart of the mountain, owing to the impracticability of effecting the necessary ascent in the open grade of the valley. The summit being attained in a straight tunnel, the descent beyond is effected by similar spiral tunnels and loops, the whole involving numerous difficult and trying problems. The grades range from 2.5 per cent. to 3.5 per cent., these permitting the use of ordinary traction without requiring the employment of rack transmission, the difficulties of the road appearing more in the location and construction than in the operation. Thus, in the section of 12 kilometers in length, between Thusis and Tiefencastel, there are 27 bridges and viaducts, and 13 tunnels, these latter representing 33 per cent. of the section.

Among the most important of the bridges may be mentioned the Solis viaduct, with its masonry arch of 42 metres span, crossing the Albula, which flows 90 metres beneath; and the Landwasser viaduct, composed of six arches of 20 metres span each, constructed on a 2 per cent. grade and a curve of 100 metres radius, the height from the foot of the piers to the track being 65 metres. There are a number of other viaducts which resemble this latter structure, and all the bridges are constructed with masonry arches with the exception of the central span of the bridge across the Rhine at Thusis, and four small bridges in the Engadine, these being made with metallic girders.

Of the tunnels the most notable is the Albula tunnel, this being the straight piercing at the summit, and being 5,864 metres, or about 3½ miles in length, the longest tunnel which has thus far been constructed for a narrow gauge railway line. The treacherous nature of the rock, and the constant infiltration of very cold water rendered this boring very difficult, and for four-fifths of its length it is lined with masonry. Small niches are provided in the walls of the tunnel as refuges for the inspectors, each post being equipped with telephonic communication to the entrance stations.

Fully as interesting from the viewpoint of the engineer are the helical tunnels, which are included in the approaches to the main Albula tunnel. Thus between Munot and Naz there are three tunnels each forming almost a complete helix in the solid rock, the radius of curvature in each case being 120 metres, and two of the tunnels being superposed one upon the other in the heart of the mountain. In this way a rise of 167 metres is effected in a distance of 5,000 metres, measured along the tortuous line of the railway, or in about 2,000 metres direct distance. Not including the Albula tunnel, the road contains 38 tunnels, with a total length of 10,161 metres, of which 7,742 metres represent masonry lining. Including the Albula tunnel there are 16 kilometres of tunnels on the line, or a little more than one-fourth of the length of the whole railway.

From Thusis to St. Moritz 57 per cent. of the line is straight and 43 per cent. consists of curves. The connection between the straight and curved portions is made by the use of parabolic sections, while the horizontal portions of the line are connected to the grades by curves of 2,000 metres radius in a vertical plane, except at the approaches to stations, where the curvature is reduced to a radius of 1,000 metres.

This road opens up one of the most picturesque portions of Switzerland to convenient travel; a matter of especial importance in view of the extent to which the region has already been visited by those who are seeking restoration to health. The popularity of Davos Platz as a health resort is well known, while St. Moritz is also largely frequented, and the completion of the new railway will add greatly to the number of visitors.

From an engineering point of view the railway will doubtless attract much attention, and the greater altitude of the Albula tunnel over the St. Gothard (the latter being but 1,149 metres above sea level) should be taken into account in considering the structural difficulties which have been so succesfully overcome in its completion.

PATENT LAW ADMINISTRATION.

THE RELATION OF PATENTS AND PATENT LAWS TO THE DEVELOPMENT OF THE MECHANIC ARTS.

Technical Society of the Pacific Coast.

It has long been the tendency to laud patent protection as one of the great causes of the development of mechanical improvement, and in the United States especially the Patent Office has been held up by many as a sort of beneficial institution from which a stream of wealth has spread over the entire land. That such a view is no longer generally held, at least among scientific engineers, is well known, and the present status of the question is well brought out in two papers presented before the Technical Society of the Pacific Coast by such well known engineers as Mr. George W. Dickie and Mr. John Richards, and published in the Journal of the Association of Engineering Societies.

After reviewing the history of the origin of patents for inventions, and showing them to be the one relic which survived the abolition of the mass of burdensome monopolies in various departments of trade du-ing the reign of James I. of England, Mr. Dickie proceeds to consider existing patent practice. He shows that patents seem to be granted upon:

"New contrivances which produce new results;

"New contrivances which produce old results;

"New combinations of old and well-known parts, whether the combination relates to the operation or the result.

"New methods of applying a well-known device.

"The whole reason for the existence of patents is the monopolizing by the inventor, for a limited period, of the benefits derived from an invention, on the supposition that there will result a lasting benefit to the public after the term of the patent has expired.

"A very small percentage of the patents granted meet this condition, for, to do so, they must cover real inventions. The mechanical arts have reached such a stage of development that new combinations of mechanical devices, in the sense of invention, is hardly possible, and, in my opinion, a patent should be issued only where some new contrivance has been invented to produce a new result. I would not have any real inventor go unrewarded, but, in order to recompense the few inventors who have done work worthy of recognition by their fellow-men, it should not be necessary for the public generally, and the mechanical arts in particular, to carry the huge load of patent-protected devices of all sorts described in patent specifications, which, owing to cleverly worded claims, prevent a free application of the proper device to accomplish the end in view."

As an example of the kind of patent which stands in the way of progress, Mr. Dickie cites a broad claim of the combination of a bulkhead, sliding door, and electric motor, this being used to enable the water-tight compartments of a vessel to be separated from each other by the control of the closing of the doors from some central point. He described the fact that such a combination was specified by the United States Navy Department, and that he himself had made such a combination, and discussed it with the officer who subsequently obtained the patent. Such a patent, in Mr. Dickie's opinion, is lacking in invention, such combinations being constantly made by engineers and draftsmen in the course of their daily work as part of the practice of their profession.

Mr. Dickie states his position as follows:

"I do not wish to be understood as opposed to all patents. I believe in rewarding everyone who, by invention or skill, succeeds in making new combinations of well-known devices to accomplish results whereby the public will be ultimately benefited, and I would have such rewards liberal and sure; but patent claims cleverly worded to cover combinations of well-known devices —to accomplish well-known results obtained for business purposes—that are to prevent others from using the same combinations or mechanical equivalents I would abolish, and thereby stop 90 per cent. of the patent business, with decided advantage to the real inventor, who at present is lost amid the multitude of imitation inventors and patent sharps."

In discussing Mr. Dickie's views, Mr. John Richards concedes much of the abuse charged against the present system, but hardly believes that the desired improvement is easy of attainment. He believes that much of the trouble lies in the fact that there are large numbers of able, skilled lawyers and patent solicitors, actively engaged in pushing the interests of the clients, while opposed to them are a limited number of Patent Office examiners, of limited attainments and with but moderate salaries, and without any especial interest in seeing that the work is judicially done. As he well says, the conduct of the United States Patent Office "is an amazing example of routine work, done by rule and apparently without personal discretion—by rules that have grown out of the conduct of the office and the circumstances of procedure."

As examples of the ignorance of patent examiners, Mr. Richards cites the well-known case of the rejection in 1853 of the invention, by Jearum Atkins, of the impulse turbine, an invention which was afterwards taken up abroad, and came back to the United States from Switzerland, Mr. Atkins receiving tardy recognition from the Patent Office in 1875 too late to do him or his country any good. Another example was the manner in which an ignition device for gas engines was rejected on irrelevant references without being considered on its merits as an invention. Mr. Richards is undoubtedly right that it is not practicable to secure as examiners capable and competent engineers and scientists for the salaries paid by the government when so much better returns can be had by competent men elsewhere. That the ideas and inventions of some of the first engineers of the age should be passed upon by men whom the applicants would not be willing to employ in minor capacities, hardly seems a satisfactory or even intelligent proceeding.

Mr. Richards concludes with the following very significant warning:

"I will venture the opinion that we are at the beginning, or a little beyond the beginning, of a war upon property in inventions, a war which will no doubt be conducted with extreme subtlety by those who own large amounts of capital and who recognize that as the only interest that should absorb the earnings of industrial production.

"As signs in this direction may be mentioned the erratic administration mentioned in this and in Mr. Dickie's paper; the want of room for the Patent Bureau and especially the paucity of legislation and attention given to this subject; the character of the bills now before Congress, and the growing opinion, if not belief, among large owners, that small or individual enterprises such as are founded on patents should not exist.

"The first movement in this war against invention will be to render patent grants unpopular, and finally obnoxious, by representing them as monopolies and by encouraging bad administration.

"The honest administration of the Bureau and of the appellate and circuit courts is seldom called in question, although dealing with vast and intricate interests, and this circumstance has, no doubt, warded off attacks that would otherwise have been made upon the system.

"This claim of honesty and pure administration, however great the errors made, is one of especial weight when so much of an opposite nature characterizes our time, and we may be excused for some congratulation over the fact that engineers and mechanics deal with truth and ascertain facts, and that even the romancers never choose their villainous characters from these callings."

TECHNICAL EDUCATION IN GERMANY.

A COMPARISON BETWEEN BRITISH AND GERMAN METHODS OF CONDUCTING ENGINEERING EDUCATION.

North-East Coast Institution of Engineers and Shipbuilders.

TECHNICAL education is such a fertile subject for discussion that papers upon the question are of frequent appearance. Many of these are merely repetitions of what has been said before, but practical information is always welcome. Among articles of this latter class must be included the paper presented by Mr. Max Wurl before the North-East Coast Institution of Engineers and Shipbuilders, upon the subject of technical education in Germany. The opinion has prevailed in many parts of the United Kingdom that the methods used in Germany possess advantages over those in vogue in Great Britain, so that a clear presentation of the former by one who is personally familiar with all the details, it of present importance and interest.

Mr. Wurl describes in general the Prussian system of education, this being representative of the other parts of the empire, and emphasises from the start the fact that the kind of technical education which can be conferred on a man depends mainly upon his general education, the latter being the root and organ by means of which the technical training is able to grow.

The German schools are, to a certain extent, under the control of the government, the Minister of Education directly controlling the universities, the secondary and the primary schools being under the direct supervision of local boards. Passing by the primary schools, Mr. Wurl discusses at some length the rivalry between the three types of secondary schools: the *Gymnasium*, the *Realgymnasium* and the *Oberrealschule*. The Gymnasium was the successor to the old mediæval school of the monks, and clung fast to the old classical training, secure in the privileges acquired with age. The Realgymnasium was on outgrowth of the older school, while the Oberrealschule is distinctly modern, replacing the classics by modern languages, and laying the foundations for subsequent technical training. Until recently, however, the old privileges of the gymnasium were all powerful, and the certificates of the newer institutions were not recognized by the universities. The influence of the present German Emperor, however, has placed all three classes of schools on the same level, and the certificates of any of them grants admittance to all faculties at any German university or technical college. Following the secondary schools, so far as technical education is concerned, come the *Hochschulen* or technical high schools, which have really grown up in Germany during the past thirty years, although some of them being based on older academical foundations, claim a greater age, the Charlottenburg School having recently celebrated, upon this basis, its hundredth anniversary.

"The aims of the technical high schools are to train the student to independent thought in technical affairs. He is taught to take a wide view in all of his considerations and all his doings; to avoid the mistake of one-sidedness which is but too common. All points practical, theoretical, commercial, etc., must be studied with equal care and thoroughness; a failure in any undertaking always shows that something has been overlooked or neglected, and on the other hand we may be sure of success if we include in our considerations all the different conditions according to their importance."

"Every student who wants to take degrees must have had at least one year's workshop practice before his first academical examination. This new clause was not introduced until an enquiry had been made as to the readiness of industrial establishments to accept volunteers in their works. 520 engine-works, shipyards, electrical works, ironworks, foundries, bridge-building firms, etc., have now agreed, and about 1,750 places are available every year, in addition to those provided by the State for training its railway engineers. For this latter group the regulation is that the State Railway engineer students work six months in the fitting shop and two months each in the machine shops, foundry, and pattern shops; they have to keep an account of their work, and being volunteers, receive, of course, no remuneration."

In entering the *Hochschule* the first year is passed by all the students in the study of general sciences, after which an election of some one of the various departments of engineering is permitted. The instruction is by lectures, practical work in drawing and designing, and experimental work in the laboratory. The students enjoy almost perfect freedom, using their time as they choose, it being found that those who have gone far enough to enter upon such a course of study realize the importance of their work and the value of time, and appreciate fully the opportunities which are placed before them. In this respect there is a marked difference between German and British methods, and although it has been doubted that the German plan would work well in England, it does seem as if men who are to make responsible engineers and practitioners should be placed in a position to realize their responsibility. The whole system, lectures, drawing room, laboratory, is such as to bring the student into close personal contact with the professor, tending to an individual development of each student, and the object is manifestly to educate him to self dependence and reliance.

A most important feature in connection with technical education in Germany is the fact that the academically trained engineer generally finds a situation after leaving college. Engineers with Hochschule education are in fairly good demand, especially those who have taken degrees. In this respect the matter is somewhat similar to that in the United States, where the graduates of the engineering schools are in demand, in marked contrast to the state of affairs in Great Britain. Indeed in this respect the British employers are in need of training themselves to the end that they may appreciate the importance of having in their establishments a number of active young men, fully trained in the latest scientific methods. German methods of teaching may not be wholly applicable to use in England, but no system can be made fully effective unless it is appreciated and supplemented by the employers.

THE NATURE OF INVENTION.

A REVIEW OF THE RELATION BETWEEN MECHANICAL DESIGN AND ORIGINALITY IN INVENTION.

J. Fletcher Moulton, K. C.—Junior Institution of Engineers.

WE have reviewed elsewhere in this issue the opinions of certain eminent engineers concerning the question of patent rights in inventions, and we have as a sort of companion subject the important aud valuable address of Mr. J. Fletcher Moulton, K. C., before the Junior Institution of Engineers, upon the question of invention, as viewed by the lawyer.

Mr. Moulton first examines what he calls the "heritage of knowledge" available for present inventors, this consisting of the accumulated growth of mechanical science which narrows as well as widens the field. Doubtless all the fundamental elements of mechanism were originally inventions of importance, and some very interesting pages of history have been written upon this branch of the subject, although the origin of many are lost in the past. Each existing element of mechanism, however, represents a present and future power conferred on mankind. All these existing elements form an important portion of the equipment of the inventor.

The present task of the inventor is too vast to be discussed at any one time, and hence Mr. Moulton limits himself to an examination of those inventions whose object is to produce by mechanical means articles which must otherwise be produced by hand work.

Some have thought that the best solution of such problems would be found in a close imitation of the manual process, but this is not necessarily the case. As Mr. Moulton well says, mechanical movements cannot be expected to replace exactly the functions of two hands whose movements are closely watched by eyes which report to a guiding intelligence, and other methods may often be found more available. Here he brings in a striking analogy.

"Doubtless you have often had to send a message by telegraph to some distant country to which the rate charged per word is high. You write your message as tersely as may be, but even thus its length is formidable. What do you do? You fly to your telegraphic code. It tells you that if you will change the phraseology of your message you can by a single code word represent a whole phrase. You thereupon set to work to recast your message so as to make it capable of being expressed in code words. When you have done so, you have not improved it as a message. It is less terse and less naturally expressed. If you were writing and not telegraphing, you would prefer to use it in its original form. But as now expressed each of the phrases of which it is composed can be sent over the wires in the form and at the price of a single word, and the cost of the whole is but a fraction of what would have been the cost of the message as originally framed. It has been recast in a form suitable for cheap telegraphing. Just so the inventor. He has to find a series of operations which, in their totality, are equivalent to the series of the hand worker. But each of these operations in itself need not be such as would be in hand labour be suitable or even practicable."

As examples of the manner in which hand operations have been "coded" into mechanical form Mr. Moulton cites the development of the sewing machine, which, with its eye-pointed needle, and double thread or chain stitch is quite different from the manual methods of sewing; and numerous similar examples will undoubtedly occur to the reader.

Mr. Moulton discusses the too common tendency of inventors to change and modify their inventions where a steadfast effort along a definite work might lead to success. The example of Babbage, who by continual changing of his plans and ideas left little which was of subsequent use or value, is an instance of the inventor who begins one thing before he has completed another.

From a commercial standpoint, the subject of invention demands especial attention. An invention must be regarded as only the beginning of a commercial enterprise, and when the invention is completed the actual business portion of the task is but begun.

Thus, for example, the linotype, which has to a great extent revolutionized the composition of printed matter, is the result of long and patient work, not only on the part of the inventor, but on the part also of those who were associated with him in making the machine a commercial success. Thousands were expended in experimental work, and it was only after years of work on the part of both inventor and capitalist that the completed machine was ready.

There is little doubt that the invention of the future will be that of the systematic pursuit of a desired end by the united efforts of inventor and promoter, and with the development of scientific methods the old-time chance inventor will be superceded by the scientific investigator, backed by ample means and full technical resources, removing his work from the domain of guess-work and placing it in the field of scientific research.

MACHINE TOOLS AND HIGH-SPEED STEEL.

THE INFLUENCE OF THE INTRODUCTION OF HIGH-SPEED TOOL STEELS UPON EXISTING MACHINE TOOLS.

J. A. Carney—Western Railway Club.

It is now generally realized that the new high-speed steels have come to stay, and that their general introduction means the supercession of many existing machine tools by those of much greater weight, power, and rigidity. The acceptance of this fact brings up for consideration another problem, the answer to the question, "What is to be done with the old tools?" This matter is discussed in a paper presented before the Western Railway Club by Mr. J. A. Carney, and its timeliness renders it appropriate for review at this time.

Specifications which are being issued for lathes and planers now require that the lathes shall stand ½-inch cut, with ⅛-inch feed at 30 feet per minute, while planers are required to cut ⅝-inch with ½-inch feed at 50 feet per minute in mild steel. Such tools are only beginning to be made, and they must necessarily cost more than their predecessors, but the machine tool builders are preparing to fill such orders, realizing that these are the standard requirements of the immediate future.

"The question arises, What shall be done with a lot of serviceable machines which are not exactly out of date, but which cannot keep up with the high speed steel pace? In a great many cases they can be speeded up and with moderate cuts the output of the tool largely increased, but it is found that the belting commences to give out and cast iron gears break. It is possible to replace cast iron gears with steel, but it is very probable that some other part will be unable to stand the strain, and the machine will be wrecked.

"The effect of belting with increased speed and cut on old tools is most disastrous, and if a tool is worked to its capacity the cost of repairs to belts and purchase of new ones will increase as much as 100 per cent. The belts, if single ply, can be replaced with light double ply at a slightly increased cost and an increased service greater in proportion, and in some cases it may be found economical to equip the machines with new cones, taking a wider belt.

"The possible time saving of high-speed steel, used with old and weak machines, is due to the fact that it will do much heavier work without regrinding and will finish most jobs without having to stop the machine and grind the tools. This item is a most valuable one and will do nearly as much to help a good output as the increased speed and cut."

Mr. Carney puts the question in the form of two queries: "Is it profitable to continue the use of tools for general use not capable of maximum output as calculated to-day? And is it profitable to reconstruct such tools to give greater speed where the design does not allow of much increased strength?"

"In reply to the first: Where the output of a tool is in such demand that it is worked to its limit of capacity, and to increase the output of the shop would mean the purchase of a similar tool, it will pay to get rid of the original tool and buy a machine of up-to-date design, capable of maximum effort as counted to-day. The single tool of modern design will more than make up its cost in the extra work done. Where a tool is not kept busy all the time it may not be advisable to spend money where increased capacity would mean increased idleness; but even then there would be an argument of cheaper work on account of the faster output.

"In reply to the second question: Increased speed can be obtained in most cases by increasing the speed of the countershaft, but great care must be taken not to tax the old tool beyond its endurance, or a series of annoying and sometimes expensive breakdowns will result.

"It is impossible to give any rule for scrapping or rebuilding old tools, because the conditions of each shop are so different, and a tool that is very nearly worthless in one shop may be a valuable adjunct to some other shop; but as a general proposition it is advisable to purchase a new tool if it can be shown that 20 per cent. of its cost can be saved per year over and above the output of the old tool."

Apart from the modifications which the new steels are making in the tools themselves, there is to be considered the effect which their use is to have upon the men.

As Mr. Carney puts it: "The education of the old-time slow-speed tempered-tool machinist is no small item." High-speed steels and high-speed machine tools necessarily involve high-speed machinists. Instead of scrapping the old men with the old tools, various methods may be employed to reconstruct them. One plan is to rearrange the tools so that the old slow speeds can no longer be obtained at all, and the necessity of putting on new cones for wider belts also permits the necessary alterations to cut out the slower steps. A better plan is to change the temper of the man as well as of the tool and by the introduction of a suitable premium or bonus system of payment cause him to have as great an interest in the increased output as has his employer. In this respect the reconstruction of the whole shop administration may well be carried along together. Modern tools mean higher speeds and lower shop costs. Improved systems of payment again act to reduce shop charges and total costs. Both include some modern method system of shop accounting and cost keeping, so that a complete reorganization of both productive and administrative methods must be carried out if the full benefits of the new processes are to be obtained.

MODERN ICE BREAKERS.

THE DESIGN AND OPERATION OF VESSELS FOR MAINTAINING NAVIGABLE CHANNELS IN ICE-BOUND WATERS.

Arthur Gulston—Society of Arts.

THE necessity for maintaining open channels in waters formerly allowed to be closed during a portion of the year has led to the construction of ice breaking vessels especially fitted, by reason of their strength and powering, to cope with the obstruction. In a paper recently presented before the Society of Arts by Mr. Arthur Gulston, and published in the *Journal* of the society, some account is given of the more powerful of the recent ice breakers, with numerous illustrations.

The first vessels described by Mr. Gulston are those made for use in the Baltic and the North Sea, and these seem very small and weak compared with the powerful vessels since constructed. Thus the *Pilot* built for use in the harbour of Cronstadt was only about 65 feet long, with an engine of 85 horse power, and the *Zarja* and the *Luna*, used in the same waters, were little more than powerful tug boats, capable of keeping a channel open only by constant action. Similar boats have been used at Hamburg for maintaining navigation in winter between Hamburg and Cuxhaven, and the shallowness of the water prevents boats of greater draught being used. The large modern ice breakers depend for their efficiency upon their ability to ride up upon the ice and break down the edge of the sheet by sheer weight, thus "biting" their way through the sheet. Such action requires that the hull shall be constructed with the greatest possible stiffness, the vessel being subjected to stresses which would break an ordinary ship in two. With this great strength there must be ample power, the combination of the two being needed to oppose the heavy resistances. Vessels of this kind are now in active service in Copenhagen, Kiel, Riga, Stockholm, Amsterdam and other ports, besides many small boats used as post boats and pilot boats in the Baltic, the German Coast, and the Black Sea. A typical example of the boats used in general service is found in the *Sampo,* operating in the port of Hangö, in Finland. This vessel, which was built on the Tyne, has a propeller at each end, the bow engine having 1,200 horse power and the stern engine 1,350 horse power. She is 202 feet long, and 2,000 tons displacement, with a full draught of 18 feet. This boat breaks through field ice of 12 to 16 inches thick at a speed of eight knots, and she can work through drift ice of 8 to 10 feet thick at a rate of two to three knots, also breaking down larger packs without much trouble.

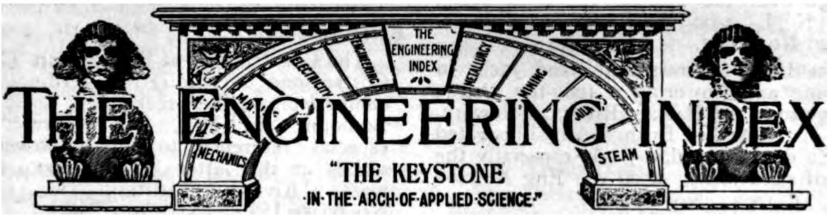
"Coming now to the design of ice breakers and vessels suitable for working in ice, they should have the bow angles and lines so arranged that when they have mounted the ice, and the ice is giving way under the vessel's weight, they must not jamb when returning o be water borne forward, always remembering that they are advancing and should remount the ice. When the ice is broken down it should pass along below the vessel or under the field ice, otherwise it lies on the water and has a tendency to jamb the vessel sidewise. This results in the ice breaker having to smash a larger proportion of ice than necessary, to give side clearance, thus absorbing more power, coal, and time, and probably resulting in having to back and charge the ice. An ice breaker should also be able to turn out of the channel she has cut, and the form of the bow lines has much effect on this manœuvre.

The designs of ice breakers vary so much that there are no certain data to guide builders; but practice has shown that the full forward form of spoon-shaped bow is not successful in hard and packed ice, as the vessel pushes the ice in front of herself, instead of cutting and dispersing it. It should be borne in mind that ice breakers, when charging in heavy ice, are in collision, so to speak, during the whole time they are at work; this therefore, entails much more strengthening at the bow and sides, as the ice to be dealt with becomes more formidable. The shell plating must be considerably increased in small boats, and still more so as the vessels increase in size; additional stringers, stronger decks, and a liberal addition to the number of bulkheads, transverse and longitudinal, as well as many pillars, become a necessity to prevent recurrence of repairs."

The greatest of modern ice breakers is the *Ermack,* built originally for use in the Baltic, but also occasionally employed elsewhere. This vessel is 335 feet long, 71 feet beam, and 8,000 tons displacement with a draught of 22 feet. She was originally fitted with a bow propeller as well as the twin screws at the stern, this propeller, with its independent engine, being intended to aid in breaking up the ice. The bow propeller was found useful for one year old ice, but became choked and useless in Polar field ice, and hence was removed before the vessel was sent to the Arctic. In solid ice two feet thick, with six to twelve inches of snow on top of it, the *Ermack* can make a speed of nine knots, while she can charge and demolish packs of ice twenty to thirty-five feet in thickness.

Especial interest attaches at the present time to the ice breakers on Lake Baikal, in Siberia, these forming a portion of the system of the Trans-Siberian Railway. The *Baikal,* which is the powerful ice breaker for this service, is 292 feet long, and 4,200 tons displacement, and is fitted with three lines of rails for the locomotives and cars forming the train, there being also a promenade deck for the use of the passengers during the crossing. The field ice on Lake Baikal forms 36 inches thick, and also forms heavy packs, but the ice breakers have been found successful in carrying the regular passenger trains and the mails across throughout the winter.

Mr. Gulston described some of the American ice breaker ferry boats, including the *St. Marie* and the *St. Ignace,* used on the Straits of Mackinaw and the *Transfer* which carries the trains of the Michigan Central Railroad across the Detroit river. The paper contains numerous interesting illustrations and valuable information concerning the successful navigation in ice-bound harbours.



THE ENGINEERING INDEX

"THE KEYSTONE IN·THE·ARCH·OF·APPLIED·SCIENCE"

The following pages form a DESCRIPTIVE index to the important articles of permanent value published currently in about two hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every article.

(1) The full title,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published.

We supply the articlcs themselves, if desired.

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer and works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of any article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the journals indexed are given.

DIVISIONS OF THE ENGINEERING INDEX.

CIVIL ENGINEERING	1005	MARINE AND NAVAL ENGINEERING	1019
ELECTRICAL ENGINEERING	1010	MECHANICAL ENGINEERING	1020
GAS WORKS ENGINEERING	1017	MINING AND METALLURGY	1027
INDUSTRIAL ECONOMY	1017	RAILWAY ENGINEERING	1032
STREET AND ELECTRIC RAILWAYS	1034		

CIVIL ENGINEERING

BRIDGES.

Arch.

The Great Railway Arch over the Adda in the Valtellina, Italy (Die Grosse Gewölbte Eisenbahnbrucke über die Adda im Veltelino in Italien) Rudolf Jaussner. With details of the centering and erection of the masonry arch of 70 metres span. 2000 w. Zeitschr d Oesterr Ing u Arch Ver—Jan. 1, 1904. No. 60427 D.

See also Civil Engineering, Construction.

Bridge Moving.

A Novel Engineering Feat. An illustrated description of method used in lowering a 1000-ton drawbridge a distance of more than ten feet by means of floating sand jacks. 2500 w. Ir Age—Dec. 31, 1903. No. 59998.

Moving a Drawbridge on the Lackawanna. An illustrated description of the removal of a double-decked bridge crossing the Passaic River in New Jersey, which involved many novel features. 400 w. Ry Age—Jan. 1, 1904. No. 59991.

Moving a Drawbridge with Sand Jacks. Fine photographs showing views while moving was in progress, with information concerning the work of lowering the bridge over the Passaic River, at Newark, N. J. 2500 w. R R Gaz—Jan. 1, 1904. No. 60067.

The Use of Scows and Sand Jacks in Moving and Lowering a 1000-ton Drawbridge over the Passaic River, at Newark, N. J. Lincoln Bush. An illustrated article describing this work, especially the use of sand jacks. 4500 w. Eng News—Dec. 31, 1903. No. 60035.

Brooklyn Bridge.

A Proposed Plan for Rebuilding the Brooklyn Bridge. An illustrated article giving plans for reconstruction of the suspension bridge between Brooklyn and New York, suggested by Mr. Gustav Lindenthal. 2000 w. Eng News—Jan. 7, 1904. No. 60138.

Erection.

The Erection of the Kemi-Isohaara Bridge in Finland (Die Aufstellung der Kemi-Isohara Brücke in Finnland) K. Snellman. An illustrated account of the erection and launching of a 125-metre span truss on the line of the Norrlandsbahn in Finland. 4000 w. Zeitschr d Ver Deutscher Ing—Jan. 2, 1904. No 60417 D.

Manhattan Bridge.

The Manhattan Bridge Across the East River. Illustrated description of this bridge at New York, the foundations and piers of which are nearly completed. 1800 w. Sci Am—Jan. 23, 1904. No. 60325.

Point Bridge.

The Point Bridge at Pittsburg, Pa., Which Must Be Rebuilt. Illustrates and describes the design of this historic bridge, which must now be rebuilt. 2000 w. Eng News—Jan. 21, 1904. No. 60316.

Railroad Bridges.

Steel Concrete Abutments and Solid Floors for Railroad Bridges. A. O. Cunningham. Illustrates and describes bridges showing new features of reinforced concrete construction. 1400 w. R R Gaz—Jan. 8, 1904. No. 60192.

Swing Bridge.

Pivot Pier Caisson and Operating Machinery for a Heavy Swing Bridge. Illustrates and describes interesting features of a very heavy combined railway and highway bridge soon to be built over the Missouri River at Kansas City, Mo. 1600 w. Eng News—Jan. 7, 1904. No. 60140.

Williamsburg Bridge.

Details of the Williamsburg Bridge Towers. Photographs illustrating some of the typical features of the steelwork connections of the bridge across the East River at New York, with description. 1100 w. Eng Rec—Jan. 16, 1904. No. 60242.

CANALS, RIVERS AND HARBORS.

Breakwaters.

The Construction of Breakwaters (Sulla Costruzione die Moli) C. Verdinois. A comparison of the breakwaters at Bilboa, Boulogne sur Mer, and Palermo, with especial reference to the improvement works at the latter harbor. 4000 w. 3 plates. Rivista Marittima—Dec., 1903. No. 60456 H.

Canal Lift.

A Canadian Lift Lock. Illustrations with brief description of a canal lift at Petersborough, Ontario. 1000 w. Engr, Lond—Jan. 15, 1904. 60399 A.

Canal Traction.

Internal-Combustion Motors for Canal-Boat Traction. Julius Kuster. Translated from *Zeitschrift des Mitteleuropaischen Motorwagen-Vereins*. Reviews the methods attempted for the mechanical propulsion of canal boats, and describes the Deutzer boat motor. 2000 w. Marine Engng—Jan., 1904. No. 60102 C.

See Electrical Engineering, Power Applications.

Irrigation Engineers.

Prospects of Employment for Young Men as Irrigation Engineers. Sir William Willcocks. On the training needed by irrigation engineers. 1400 w. Engr, Lond—Jan. 15, 1904. No. 60395 A.

Nile.

The Irrigation of the Nile Valley. John Ward. An illustrated account of the present condition of Egypt, the effect of the new dams, and other engineering works. 4400 w. Page's Mag—Jan., 1904. No. 60270 B.

Piers.

The Proposed Extension of the North River Pier Head Line Near 23d St., New York City. Gives condensed reports of Mr. Whinery in favor of the proposed extension and of the Board of Engrs. opposing it, with editorial comment. 6000 w. Eng News—Dec. 31, 1903. No. 60034.

River Improvement.

Argentine Rivers. E. L. Corthell. Explains the hydraulic features of the Rio de la Plata and its tributaries, the products of this region, &c., giving reports of surveys and other information. Ill. 6300 w. Eng News—Jan. 7, 1904. No. 60141.

The Artificial Feeding of the Neste (L'Alimentation Artificielle de la Neste) P. Frick. An illustrated account of the works for the diversion of water from lakes in the Pyrenees for the maintenance of the level in the river and canal of Neste in the upper Pyrenees. 1800 w. Génie Civil—Jan. 2, 1004. No. 60405 D.

The Improvement of the Yahara River. James M. Gilman. An illustrated account of proposed improvements in a small stream near Madison, Wis., connecting two lakes. 3500 w. Wisconsin Engr—Dec., 1903. No. 59965 C.

Stamboul.

The New Harbor Works at Haidar-Pasha, opposite Stamboul (Die Neuen Hafenwerke von Haidar-Pascha gegenüber Stambul). With illustrations showing the arrangement of the harbor and the construction of the breakwater at Haidar-Pasha, opposite Constantinople. 2000 w. Zeitschr d Ver Deutscher Ing—Jan. 9, 1904. No. 60423 D.

Waterways.

Harbors and Waterways in 1903. A review of the last year's progress, especially in England. 3800 w. Engr, Lond—Jan. 1, 1904. No. 60128 A.

CONSTRUCTION.

Air Lock.

An Air Valve for Regulating the Time of Passing Through an Air Lock: Used in the Kiel Dry-Dock Construction. Illustrated description of an apparatus to make it impossible for workmen to pass through the air lock in so short a time as to cause risk of injury. Also editorial. 1700 w. Eng News—Jan. 21, 1904. 60321.

Building Construction.

Structural Details of the Kuhn-Loeb Building, New York. Details of a twenty-story steel cage structure are illustrated and described. 2200 w. Eng Rec—Jan. 2, 1904. No. 60063.

Building Details.

Supporting an Old Wall from a New Building. Illustrates and describes a difficult piece of work successfully accomplished, in the course of enlarging the Imperial Hotel of New York City. 900 w. Eng Rec—Jan. 16, 1904. No. 60243.

Concrete Construction.

The Use of Concrete Blocks in Manhole Construction. Hugh C. Baker, Jr. Illustrates and describes a type of manhole construction used for subways for electrical cables. 1500 w. Eng News—Jan. 21, 1904. No. 60319.

See Civil Engineering, Bridges.

Dam.

The Avignonnet Dam (Die Talsperre von Avignonnet). C. Andrae. A description of the dam across the river Drac in the Avignonnet valley, Isère, France, in connection with the development of hydraulic power. The entire structure is of concrete. Two articles, 3000 w. Schweiz Bauzeitung—Dec. 19, 26, 1903. No. 60457 each B.

Excavation.

Cost of Earth Excavation by Steam Shovel. Daniel J. Hauer. Gives an account of a month's work done in North Carolina, with remarks on factors affecting cost. 3500 w. Eng News—Dec. 31, 1903. No. 60027.

Factory Architecture.

The Warehouse and the Factory in Architecture. Russell Sturgis. An illustrated critical discussion of buildings of this class. 4300 w. Arch Rec—Jan., 1904. Serial. 1st part. No. 59954 C.

Fireproofing.

Fire Proof Construction in America (Feuersichere Eisenbauten in den Vereinigten Staaten von Amerika) M. Gary. A fully illustrated description of the method of steel skeleton building construction, with casing of fire brick. 4000 w. Zeitschr d Ver Deutscher Ing—Jan. 9, 1904. No. 60420 D.

Foundations.

Foundations. Abstract of a paper read by Baron Siccama at a recent meeting of the Civ. & Mech. Engrs. Soc. Considers raft and sand foundations, the use of piles, the well method, &c. 2300 w. Gas Wld—Jan. 16, 1904. No. 60386 A.

Grade Elevation.

Raising the Grade of Galveston. An interesting illustrated description of the work of building a sea-wall, and raising the grade of the flooded portion of the city above high water, after the almost total destruction in Sept., 1900. 2000 w. R R Gaz—Jan. 1, 1904. 60068.

Rapid Building.

How to Get Despatch in Construction. Discusses facts brought out in a recent paper by Charles Heathcote, bearing upon methods of securing economy and despatch in construction. Considers the building of the Westinghouse Works at Manchester, Eng. 2400 w. Jour Gas Lgt—Dec. 22, 1903. No. 59978 A.

Reinforced Concrete.

A Concrete Arch Bridge with Bar and Stirrups Reinforcement. An illustrated description of the bridge which carries Seeley St. over Prospect Ave., in Brooklyn, New York. It is a skew structure in which small bars and metal netting are used for reinforcing the concrete arch. 1200 w. Eng News—Dec. 31, 1903. No. 60032.

A Concrete-Steel Factory Building with Fifty-two-Foot Roof Girders. Illustrated description of a building in Long Island City, built entirely of reinforced concrete. 3300 w. Eng Rec—Jan. 16, 1904. No. 60240.

A Reinforced Concrete Tunnel (Tunnel in Eisenbetonkonstruktion). L. Zöllner.

Illustrating a tunnel lining on the Wayss system near Wasserburg, Bavaria. 1000 w. Beton u Eisen—No. V. 1903. No. 60480 H.

Big Rock Creek Concrete-Steel Arch on the Chicago, Burlington & Quincy Railway. Illustrates and describes a bridge being built near Plano, Ill., to replace a steel bridge. 1000 w. Eng Rec—Jan. 2, 1904. No. 60062.

Bridge Construction in Munich (Münchener Brückenbauten). W. Binswanger. Describing especially the new Cornelius bridge across the Isar. 4000 w. Beton & Eisen—No. V. 1903. No. 60481 H.

Reinforced Concrete Arch Bridge Over the Yellowstone River, Yellowstone National Park. H. M. Chittenden. Illustrated description of the bridge and its erection. 2300 w. Eng News—Jan. 14, 1904. No. 60248.

Some of the Causes of Recent Failures of Reinforced Concrete. Julius Kahn. The writer's views as to the causes of failure of a material in which he has the utmost confidence. 4200 w. Eng News—Jan. 21, 1904. No. 60322.

The Calculation of the Stresses and the Practical Design of Structures of Steel Concrete. Walter W. Colpitts. Considers the properties which render it adaptable to railway structures, discussing its applications and describing designs and calculations. Ill. 6600 w. Ry Age—Jan. 8, 1904. No. 60167.

The Extension and Elasticity of Reinforced Concrete (Allongement et Elasticité du Beton dan les Pièces Armées) G. Considère. A discussion of the results of experiments made in the laboratory of the Ponts et Chaussées with especial reference to the elasticity of the concrete itself. A parallel translation in German is given. 3000 w. Beton u Eisen—No. V. 1903. No. 60479 H.

The Graphical Computation of Reinforced Concrete Beams (Die Graphiche Berechnung von Balken aus Eisenbeton) F. von Emperger. Discussing the application of grapho-statistics to reinforced concrete structures with a general diagram for practical use for beams. 4000 w. Beton u Eisen—No. V., 1903. No. 60483 H.

Roads.

An example of Thin Macadam Road Construction Along the Charles River, Mass. J. Albert Holmes. Describes the road previous to the placing of the macadam surface and the work. Ill. 800 w. Eng News—Jan. 14, 1904. No. 60251.

Shield.

An Improved Tunneling Shield. Describes a type of shield designed by Cornelius G. Hastings, for application to tunnels of a considerable range of sizes through various classes of material, seeking to overcome the difficulties encountered in submarine and some land tunneling. Ill. 1500 w. Eng Rec—Jan. 2, 1904. No. 60061.

Struts.

Statical Investigations upon Crooked Struts (Statische Untersuchung Einfach Gekrümmter Stäbe) G. Ramisch. A mathematical analysis, deriving formulas for various sections and shapes. 3500 w. Zeitschr d Oesterr Ing u Arch Ver—Jan. 1, 1904. No. 60425 D.

Tunnels.

The Cincinnati Water-Works Tunnel. Paul G. Brown. An illustrated description of the construction. 1500 w. Eng News—Dec. 31, 1903. No. 60036.

The Highest Tunnel in Europe. Brief illustrated description of the Albula tunnel in Switzerland. 600 w. Sci Am Sup—Dec. 26, 1903. No. 59944.

The Pennsylvania Tunnel at New York City. Gives a diagram showing the location of these tunnels under the Hudson and East Rivers, with an outline of the work. 1600 w. Ills. Sci Am—Jan. 16, 1904. No. 60246.

The Simplon Tunnel. Reviews the history of this great undertaking, commencing a detailed description of the construction. Ill. 5400 w. Trac & Trans—Jan., 1904. Serial. 1st part. No. 60294 E.

Underpinning.

Underpinning a Corner Column on a Slender Pier. Brief illustrated description of work of special difficulty executed in New York. 600 w. Eng Rec—Jan. 9, 1904. No. 60188.

MATERIALS.

Brick Making.

Brick Making Plant of the Western Brick Co., Danville, Ill. Illustrated description of plant for the manufacture of building and paving brick. 2400 w. Eng News—Jan. 14, 1904. No. 60250.

Buckling.

More Accurate Formulas for Buckling (Genauere Formeln für die Knickkraft) Adolf Francke. With especial reference to pillars and struts of reinforced concrete giving a mathematical analysis. 3000 w. Beton u Eisen—No. V. 1903. No. 60482 H.

Cement.

The Cost of Raw Materials for Portland Cement Manufacture. Morris M. Green. Information of interest, giving estimates. 1800 w. Eng Rec—Jan. 23, 1904. No. 60356.

Cement Works.

The Almendares Portland Cement

Works, Cuba. An illustrated description of works near Havana. 2500 w. Eng Rec—Jan. 9, 1904. No. 60184.

Clays.

On the Role Played by Iron in the Burning of Clays. Prof. Edward Orton, Jr. An illustrated article giving the principal facts concerning the behavior of iron in clay burning. 2000 w. Brick—Jan. 1, 1904. No. 60183.

Corrosion.

The Protection of Steel from corrosion. Charles L. Norton. Extract from report of the Insurance Engineering Experiment Station. Describes tests upon metal embedding in concrete. 1600 w. Eng News —Jan. 14, 1904. No. 60249.

Dynamite.

Heating a Dynamite Storage House. Illustrated description of the type of dynamite storehouse adopted by the Fire Commissioners of New York. 700 w. Metal Work—Jan. 9, 1904. No. 60075.

Terra Cotta.

The "New York" Reinforced Terra Cotta Arch. An illustrated account of an official test made of this new type of building construction. 4500 w. Ins Engng—Dec., 1903. No. 59955 C.

MEASUREMENT.

Field Engineering.

Two Problems in Field Engineering. Arnold Emch. Gives the solution of an application of the theory of bicircular quartics, and an application of projective geometry. 1000 w. Eng News—Dec. 31, 1903. No. 60037.

Flow.

Methods of Measuring the Flow of Streams. John C. Hoyt. Explains the method used by the U. S. Geological Survey. 1800 w. Eng News—Jan. 14, 1904. No. 60253.

Tide Predictor.

Lord Kelvin's Automatic Tide Predictor. An illustrated description of this machine which has recently come into the possession of the National Physical Laboratory of Great Britain. 3500 w. Sci Am Sup—Jan. 23, 1904. No. 60328.

Water Gauge.

The Haskell Self-Registering Water Gauge. G. A. M. Liljencrantz. Illustrates and describes the main features of this gauge for recording the level of streams, etc., invented by E. E. Haskell, its operation, reliability, and manner of using. 6000 w. Jour W Soc of Engrs—Dec., 1903. 60341 D.

MUNICIPAL.

Fire Fighting.

Philadelphia's New Fire Fighting Service. An illustrated description of central pumping station and independent pipe system whereby high pressures are obtained directly at the hydrants. 3200 w. Ir Age—Jan. 21, 1904. No. 60308.

Pavements.

The Economic Designing of Pavements. A. W. Dow. Read at Baltimore meeting of the League of Am. Municipalities. Discusses ancient and modern methods, and three methods that the writer thinks desirable. 4200 w. Munic Engng—Jan., 1904. No. 59971 C.

Sanitation.

Sanitary Engineering in 1903. A review of the progress made during the past year in England, discussing present methods. 2500 w. Engr, Lond—Jan. 1, 1904. No. 60130 A.

Sanitary Law. H. Harcourt Verden. Read before the Inst. of San. Engrs., Ltd. Deals only with points of importance to sanitary engineers in Great Britain. 3300 w. Engng—Jan. 1, 1904. No. 60215 A.

Septic Tank.

The Septic Tank for the Treatment of Sewage at the Soldiers' Home Near Santa Monica, Cal. James D. Schuyler. Illustrated description of the tank with statement of its operation. 3000 w. Munic Engng—Jan., 1904. No. 59969 C.

Sewage.

Sewage Disposal in Iowa. Prof. A. Maraton. Information and illustrated descriptions of plants in various parts of the state. Discussions. 12300 w. Jour W Soc of Engrs—Dec., 1903. No. 60340 D.

Theatre Fire.

The Chicago Theatre Fire. Gives a description of the Iroquois Theatre, showing sketch plans and sections, and reviewing the causes of the disaster. 3500 w. Eng News—Jan. 7, 1904. No. 60142.

The Structural Effects of the Iroquois Theatre Fire. An illustrated article showing the condition of the building after the fire, and explaining the arrangement. Also editorial. 2000 w. Eng Rec—Jan. 9, 1904. No. 60187.

Waste.

The Sanitary Disposal of Municipal and Institutional Waste by Cremation. Selections from a paper by W. F. Morse, read at meeting of the Am. Pub. Health Assn., giving a statement of reasons for the success of garbage destruction in England and the practical failure in America. Ill. 1800 w. Munic Engng—Jan., 1904. No. 59970 C.

WATER SUPPLY.

Conduit.

The Conduit of the Jersey City Water

Supply Company. Illustrated detailed description of the steel pipes and the terminal gate house and connections. 2500 w. Eng Rec—Jan. 9, 1904. Serial. 1st part. No. 60185.

Filtration.

The Belmont Filtration Works. John W. Hill. Illustrated detailed description of these works for filtering the supply of West Philadelphia. 5500 w. Jour Fr Inst—Jan., 1904. Serial. 1st part. No. 60333 D.

The Failures and the Possibilities of Water Filtration. Allen Hazen. Abstract of remarks made at the Sanitary Con. of the Health Officers of Conn. Discusses the reasons for some failures. 2000 w. Eng News—Dec. 31, 1903. No. 60029.

The Filter Galleries for the Water Works of Laredo, Texas. A. L. McLane. Detailed description. 1300 w. Eng Rec—Jan. 9, 1904. No. 60186.

Impure Water.

Some Lessons of the Butler Typhoid Epidemic. Editorial on the need of sanitary reforms and the deaths due to polluted water. 1700 w. Eng News—Dec. 31, 1903. No. 60033.

Mains.

Relocating a Large Pumping Main Under Pressure, at Philadelphia. Seth M. Van Loan. Outlines the reasons why the undertaking was necessary, and gives an Illustrated description of this work. 11000 w. Eng Rec—Jan. 23, 1904. No. 60355.

Meter Tests.

Some Six-Inch Meter Tests and How They Were Made. Frank C. Kimball. Illustrates and describes apparatus and methods used in testing, stating results. Discussion. 9600 w. Jour N E Water Wks Assn—Dec., 1903. No. 60336 F.

Reservoirs.

Covering the Natick, Mass., Reservoir with a Concrete Roof. Frank L. Fuller. Illustrated description of this work. 11000 w. Jour N E Water Wks Assn—Dec., 1903. No. 60338 F.

The New Sebago Lake Reservoir of the Portland Water Company. Edmund M. Blake. An account of the supply of Portland and the recent improvements to increase it which involved interesting engineering features. Ill. 4000 w. Eng Rec—Jan. 23, 1904. No. 60352.

Storage.

The Storage of Flood Water. Prof. Henry Robinson. From a paper read before the British Assn. of W.-Wks. Engrs. Considers the subject principally as related to England. General discussion. 4500 w. Jour Gas Lgt—Dec. 22, 1904. No. 59980 A.

Stray Currents.

See Electrical Engng., Measurement.

Supply.

New Water Supply for Margate. An illustrated article describing the new water-works for this English seaside resort. 1100 w. Engr, Lond—Dec. 25, 1903. No. 59981 A.

Typhoid.

The Responsibility for Controlling the Spread of Typhoid Fever. Editorial on the causes of epidemic typhoid, and what should be done to prevent communication. 3000 w. Eng News—Jan. 21, 1904. No. 60320.

ELECTRICAL ENGINEERING

COMMUNICATION.

Exchange.

The New Automatic Telephone Exchange at Grand Rapids, Mich. Edward J. Hart. Illustrated description. 2500 w. Elec Wld & Engr—Jan., 1904. No. 60373.

Printing-Telegraph.

The Berlin Printing-Telegraph Central Station. Dr. Alfred Gradenwitz. Illustrated detailed description. 1000 w. Sci Am—Dec. 26, 1903. No. 59942.

Simultaneous.

Simultaneous Telegraphy on the Hughes System and Telephony (Doppelter Hughesbetrieb und Gleichzeitiges Fernsprechen in Doppelleitungen). H. Pfitzner. Illustrated description of a system, modified from that of Dejongh, used in the German Imperial telegraph office. 1000 w. Elektrotech Zeitschr—Dec. 17, 1903. No. 60431 B.

Space Telegraphy.

Blockmann Radio-Telegraph System A. Frederick Collins. Shows how this system is the outcome of experiments of Heinrich Hertz in refracting electric waves, and briefly describes the invention. Ill. 1800 w. Elec Wld & Engr—Jan. 16, 1904. No. 60261.

Major Wireless Telegraph Progress for the year 1903. Joseph B. Baker. Reviews the work of various experimenters during the year. 3300 w. Elec Rev, N. Y.—Jan. 9, 1904. No. 60182.

The De Forest Wireless Tests Across the Irish Channel. An illustrated account of a series of experiments conducted under the auspices of the British post-office. 900 w. Sci Am—Jan. 16, 1904. No. 60244.

The Variation of Potential Along the Transmitting Antenna in Wireless Telegraphy. C. A. Chant. A detailed account of an examination of the aërial wire used to radiate the waves in wireless telegraphy. 5000 w. Am Jour of Sci—Jan. 1904. No. 60329 D.

Wireless Telegraphy Theory. An explanation of phenomena, showing the propagation at great distances resolves itself into hemispherical waves. Discusses views of Prof. Blondel. 1300 w. Elec Wld & Engr—Jan. 2, 1004. No. 60086.

See Electrical Engineering, Measurement.

Telegraphy.

Present Conditions in Telegraphy. Francis W. Jones. Reviews the improvements to increase the efficiency, giving records of remarkable speeds, and noting proposed inventions. 1200 w. Elec Rev, N. Y—Jan. 9, 1904. No. 60181.

Telephony.

The Cost of the Glasgow Corporation Telephone System. Analyzes the capital account under its natural divisions, extracting the average cost per unit of work, and determines the average capital cost per working line. 2500 w. Engng—Dec. 25, 1903. No. 60117 A.

The Efficiency of Modern Telephone Equipment. M. A. Edson. Abstract of a paper read before the Chicago Elec. Assn. Discusses the present efficiency of the engineering elements which enter into the construction of a modern exchange. 3000 w. Am Electn—Jan., 1904. No. 60-108.

The Telephone in 1903. C. J. H. Woodbury. Reviews the improvements during the past year. 1500 w. Elec Rev, N. Y—Jan. 9, 1904. No. 60180.

Time Service.

The Naval Observatory's New Year's Greeting to the World. George C. Maynard. An account of the great telegraphic achievement by which the ending of the year 1903 in Washington was signalled around the world. 1400 w. Elec Rev. N. Y—Jan. 9, 1904. No. 60177.

DISTRIBUTION.

Switches.

An Emergency or Master Switch for Central Stations. W. M. Thornton. Suggests that an auxiliary switch be so fitted that, in emergency, all the fields could be simultaneously short-circuited. 1500 w. Elect'n, Lond—Jan. 15, 1904. No. 60390 A

Switch Construction. N. C. Woodfin. An illustrated description of a recently designed single-knife switch, aiming at simplicity and effectiveness. 1400 w. Elec Rev, Lond—Dec., 25, 1903. No. 59977 A.

Wiring.

Alternating Current Wiring. George T. Hanchett. Gives means of calculating wires for alternating current circuits of small magnitude. 1200 w. Cent Sta—Jan. 19, 1904. No. 60222.

The Grounded Neutral. R. S. Hale. Discusses four ways in which the wiring on a three-wire system with grounded neutral can be done more cheaply and as safely as at present. 1700 w. Elec Wld & Engr—Jan. 16, 1904. No. 60260.

ELECTRO-CHEMISTRY.

Batteries.

Fuel and Heat Batteries. C. J. Reed. A description of the Reid battery. 2000 w. Elec-Chem Ind—Jan., 1904. No. 60174 C.

Bleaching.

Two New Forms of Electrolytic Cell for Production of Bleaching Solutions. John B. C. Kershaw. An illustrated description of two new forms of apparatus for the production of hypochlorite solutions. 1700 w. Elec Rev, Lond—Dec. 25, 1903. No. 59976 A.

Carbon Cell.

Electricity Direct from Carbon. Prof. Richard Lorenz. Abridged translation of a paper read before the Physical Society of Zurich. A study of the various methods, showing that the carbon cell is theoretically possible, and stating the difficulties involved. 4500 w. Elec-Chem Ind—Jan., 1904. No. 60173 C.

Electric Furnaces.

Electric Furnace Industries in 1903. F. A. J. Fitz Gerald. A review of the past year of the industries using electric furnaces, giving examples that indicate probable future developments. 2000 w. Elec-Chem Ind—Jan, 1904. No. 60170 C.

Electrometallurgy.

The Electrical Manufacture of Steel. P. McN. Bennie. An abridged translation of M. Gustave Gin's description of his latest process for the production of steel by electrical means. Ill. 3300 w. Elec-Chem Ind—Jan., 1904. No. 60175 C.

Electro-plating.

Differential or Localized Electro-Plating. Sherard Cowper-Coles. Illustrated description of methods. 1100 w. Elec-Chem & Met—Dec., 1903. No. 60345 E.

Electrotypes.

Rapid Methods for Producing Electrotypes. Sherard Cowper-Coles. Illustrated descriptions. 800 w. Elec-Chem & Met—Dec., 1903. No. 60346 E.

Elements.

The Rare Elements. Victor Lenher,

Considers the new radioactive elements and their actions, and also other elements and their characteristics. 3000 w. Elec-Chem Ind—Jan., 1904. Serial. 1st part. No. 60172 C.

Researches.

Recent Electrical Researches by Berthelot. Translated from the French. The relation between the intensity of the voltaic current and the manifestation of the electrolytic output. 3600 w. Sci Am Sup—Dec. 26, 1903. No. 59945.

Review.

Electrochemistry in 1903 (Die Elektrochemie im Jahre 1903). Dr. M. Krüger. A general review. Serial. 1st part. 4000 w. Elektrochem Zeitschr—Jan., 1904. No. 60451 G.

The Present Status of the Electro-Chemical Industries. Joseph W. Richards. Reviews briefly the various industries showing promising progress in most of them. 2500 w. Elec-Chem Ind—Jan., 1904. No. 60169 C.

Smelting.

The Electric Smelting of Iron and Steel. An illustrated article describing various processes and investigating the electric methods of smelting steel, concluding that under existing conditions the actual manufacture of iron and steel by electric methods can not be profitably carried on. 4500 w. Ir & Coal Trds Rev—Jan. 15, 1904. No. 60518 A.

Storage Batteries.

Care and Management of Storage Batteries. Edward Lyndon. Outlines the troubles to which batteries are subject and the methods of treating them, also indicates the more important records which should be taken. 1800 w. Elec Rev, N. Y—Jan. 23, 1904. Serial. 1st part. No. 60359.

The Edison Battery—Details of Construction. Gives the main constructional details of this new cell. Ill. 2500 w. Auto Jour—Jan. 2, 1904. No. 60199 A.

The Edison Storage Battery. Hugh Dolnar. A report of the Edison iron-nickel battery. 4500 w. Automobile—Dec. 26, 1903. No. 59928.

The Edison Storage Battery. Hugh Dolnar. Information of interest with condensed report of W. Hibbert. 2500 w. Am Mach—Dec. 31, 1903. No. 60003.

See also Mechanical Engineering, Automobiles.

Stripping.

Electrolytic Stripping of Metals. Prof. Charles F. Burgess. An illustrated detailed description of the process used. 4000 w. Elec-Chem Ind—Jan., 1904. No. 60171 C.

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Protection.

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Puncture.

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Radioactivity.

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Wld & Engr-

Sir Oliver Lodge on Radium. Abstract of a lecture on "Radium and its Meaning." 2800 w. Elec Engr, Lond—Jan. 8, 1904. No. 60290 A.

Roentgen Apparatus.

The Orthodiagraph, an Apparatus for Determining the True Shape and Size of Internal Organs. Illustrates and describes the apparatus and its operation. 900 w. Sci Am—Jan. 16, 1904. No. 60245.

GENERATING STATIONS.

Canandaigua.

A Modern Electric Railway Power Plant, Canandaigua, N. Y. An illustrated description of a finely equipped plant. 2000 w. Eng Rec—Jan. 16, 1904. No. 60241.

Commutation.

The Commutation of Current in Dynamos (Die Stromwendung in Kommutierenden Maschinen). Karl Pichelmayer. Paper before the Vienna Elektrotechnischer Verein, on sparking at the commutators of direct-current machines and means for preventing it, with diagrams and discussion. 4000 w. Zeitschr f Elektrotechnik—Jan. 3, 1904. No. 60447 D.

The Theory of Commutation (Zur Theorie der Stromwendung). Karl Pichelmayer. Illustrated discussion of sparking at the commutators of direct-current machines and of commutation theories. 800 w. Elektrotech Zeitschr—Dec. 31, 1903. No. 60435 B.

Double-Current.

The Copper Losses and Economy of Double-Current Generators (Kupferverluste und Ausnutzungsfähigkeit der Doppelstromgeneratoren). Felix Horschitz. An Illustrated discussion of the action of the combined direct and alternating currents in the armature, and a comparison with direct current alone. 3000 w. Elektrotech Zeitschr—Jan. 14, 1904. No. 60442. B.

Electrical Power.

The Production of Electrical Power. The first of a series of articles aiming to give a popular explanation of methods employed in generating and utilizing electric current for tramway purposes. Tram & Ry Wld—Jan. 14, 1904. Serial. 1st part, No. 60521 B.

Gas Power.

Central Station Operated by Gas Power. An illustrated detailed description of the plant of the Bradford Electric Light & Power Co., in Pennsylvania. 2300 w. Am Elect'n—Jan., 1904. No. 60105.

Heyland Generator.

A New Alternator With Direct Excitation by Alternating Currents (Eine Neue Wechselstrommaschine mit Direkter Erregung durch Wechselstrom). Alexander Heyland. Illustrated paper before the Elektrotechnischer Verein, with extended discussion. Current from the machine passes through a commutator direct to the field coils. 8000 w. Elektrotech Zeitschr—Dec. 17, 1903. No. 60432 B.

Hydro-Electric.

Hydro-Electric Power System, Near Sassenage, Isere, France. E. Guarini. Illustrated description. 1000 w. Engr, U.-S. A—Jan. 15, 1904. No. 60268 C.

The First Hydro-Electric Station of Greece. E. Guarini. An illustrated account of the hydro-electric pumping station for the drainage of Lake Copais. 1800 w. Engineering Magazine—Feb., 1904. No. 60474 B.

Plant of the Columbus Power Company, Columbus, Georgia. Illustrated description of a plant built to furnish electric power for public sale and to drive a mill. 4000 w. Eng Rec—Jan. 16, 1904. No. 60239.

The Chèvres Hydraulic Station Near Geneva. B. F. Hirschauer. An illustrated description of one of the largest and best equipped plants in Europe. 3000 w. Elec Rev, N. Y—Jan. 23, 1904. No. 60360.

Water-Power Electrical Development in Northern Indiana. Illustrated account of the Twin-Branch power-house, ten miles west of Elkhart, Ind., on the St. Joseph river. The first of a number of projected plants. 1400 w. Eng Rec—Jan. 23, 1904. No. 60353.

Water Power Electrical Generating Plant at Riva, Tyrol. Franz Koster. Illustrates and describes a hydro-electric plant serving less than 8000 people. 1500 w. Elec Wld & Engr—Jan. 2, 1904. No. 60084.

See also Mechanical Engng., Hydraulics.

Statistics.

Statistics of the Electric Stations in Germany (Statistik der Elektricitätswerke in Deutschland). Complete statistical tables of all the German central stations on April 1, 1903, with editorial. 12000 w. Elektrotech Zeitschr—Dec. 24, 1903. No. 60433 B.

Storage Batteries.

Operation of Storage Batteries and Boosters. W. T. Fernandez. Considers the daily operation of batteries, and cell-switches and boosters. Diagrams. 2000 w. Am Elect'n—Jan., 1904. No. 60112.

Vienna.

The Vienna, Austria, Municipal Light and Power Plant. Franz Köster. Illustrated detailed description. 3300 w. Elec Rev, N. Y—Jan. 9, 1904. No. 60178.

Weak Currents.

Modern Methods of Generating Weak

Electric Currents (Ueber Moderne Stromquellen fur Schwachstrombetriebe). Emil Muller. Discussing the use of dynamos, storage batteries, etc., for the generation of weak currents for telegraphy and similar service. Two articles, 7500 w. Zeitschr d Oesterr Ing u Arch Ver—Dec. 18, 25, 1903. No. 60424 each D.

See also Mechanical Engineering, Steam Engineering.

LIGHTING.

Distribution.

On the Distribution of Light from Incandescent Lamps. Lancelot W. Wild. On the choice of lamps for various uses, and the measurement of candle-power. 900 w. Elec Rev, Lond—Jan. 1, 1904. No. 60203 A.

Enclosed Arc.

Notes on the Enclosed Electric Arc. Elihu Thomson. Explanation of differences between the enclosed and open arc, particularly considering the enclosed arc and its working. 3000 w. Cent Sta—Jan., 1904. No. 60223.

Incandescent Lamps.

The Gas That Failed. Alton D. Adams. Review of the growth of the incandescent lamp as compared with gas. 2500 w. Elec Wld & Engr—Jan. 2, 1904. No. 60085.

Lamps.

Intensive Electric Lamps (Mitteilungen ueber Intensivflammen bogen lampen). H. Zeidler. A description of recent lamps made by the A. E. G., using carbons impregnated with salts acting to increase the length of the arc. 1000 w. Glasers Annalen—Jan. 15, 1904. No. 60454 D.

MEASUREMENT.

Form Factor.

The Measurement of the Form Factor of an Alternating Voltage. Translation of an article by P. Rose and A. Kuhns in *Elektrotechnische Zeitschrift*. The form factor is the ratio of the effective value to the average value of the voltage. Gives methods of measurement. 1400 w. Elec Engr, Lond—Jan. 8, 1904. No. 60289 A.

Meter.

New Two-Rate Meter. E. S. Shoults. An illustrated description of the Aron double-tariff meter, with statement of the advantages. 1700 w. Elec Rev, Lond—Jan. 1, 1904. No. 60204 A.

Potential Regulator.

Compensated Potential Regulator for Single-Phase Current (Kompensieter Potentialregulator für Einphasenstrom). Dr. L. Fleischmann and Dr. F. Eichberg. Theory and description, with diagrams. 600 w. Zeitschr f Elektrotechnik—Jan. 10, 1904. No. 60418 D.

Potentiometer.

Potentiometer. W. Clark Fisher. An illustrated description of a new instrument, showing its essential difference and improvement on the older form. Ill. 3500 w. Elect'n, Lond—Jan. 15, 1904. No. 60391 A.

Resistances.

The Accurate Measurement of Small Resistances with the Kelvin Double Bridge. W. Jaeger, S. Lindeck, and H. Diesselhorst. From the *Physics-Technical Reichsanstalt*. Describes the measurement of resistances comprising principally standards from 0.1 ohm to 0.0001 ohm. 900 w. Elec Rev, N. Y—Jan. 2, 1904. Serial. 1st part. No. 60010.

Slip Meter.

A New Slip Meter (Ein Neuer Schlüpfungsmesser). Angelo Bianchi. Illustrated description of methods and apparatus for measuring the slip of induction motors. 800 w. Elektrotech Zeitschr—Dec. 24, 1903. No. 60434 B.

Speed Indicators.

Electrical Speed Indicators—Some Unsuccessful Attempts. A. S. Cubitt. Gives an illustrated description of experimental investigations made by the writer, stating the reasons for their proving more or less unsuccessful. 3500 w. Elec Engr, Lond—Jan. 1, 1904. No. 60200 A.

Stray Currents.

Measurements of Electric Currents on Gas and Water Pipes in Geneva, Switzerland. Gives results of a recent electrical survey. 1000 w. Eng News—Dec. 31, 1903. No. 60031.

Testing.

Testing Large Alternators. W. E. Burnand. Describes method which is believed to overcome objections made to other methods. The armature circuit is divided into quarters so as to abolish the unbalanced mechanical stresses forcing alternating current of the same frequency as that of the generator through the armature coils. Also editorial. 3700 w. Elec Wld & Engr—Jan. 2, 1904. No. 60081.

Testing Large Alternators. W. E. Burnand. Suggests a modification of a method by W. M. Mordey, published 11 years ago. The test is applied under almost the conditions of service. 1800 w. Elect'n, Lond—Jan. 15, 1904. No. 60389 A.

Voltameter.

Measurement of Current by Copper Voltameter. J. L. Dickson. Describes method. 400 w. Elec Wld & Engr—Jan. 16, 1904. No. 60259.

Wave Forms.

A Method of Photographing Alternating-Current Wave Forms. C. J. Spencer. Illustrates and describes a modification of an oscillograph of the writer's construction, which employs an alternating current arc lamp as a source of light for the reflected photographing ray. 900 w. Elec Wld & Engr—Jan. 23, 1904. No. 60371.

A Wave Meter. Johannes Dönitz. From *Elektrotechnische Zeitschrift*. Discusses methods of measuring wave lengths in space telegraphy, describing instrument. Ill. 1500 w. Elect'n, Lond—Jan. 1, 1904. No. 60206 A.

Photographing Alternating-Current Wave-Forms with the New Duddell Oscillograph. Frank C. Perkins. Illustrated description of apparatus and its use. 1800 w. Elec Rev, N. Y—Jan. 2, 1904. No. 60011.

POWER APPLICATIONS.

Canal Traction.

• Electric Haulage on the Teltow Canal, Germany (Elektrische Treidelei auf dem Teltow-Kanal). Illustrated description of electric locomotive and of electric towboat. 1000 w. Elektrotech Zeitschr—Dec. 31, 1903. No. 60437 B.

Cranes.

A New Line of Electric Traveling Cranes. Illustrates and describes the interesting features of special types recently made by the Case Mfg. Co. 1800 w. Ir Age—Jan. 7, 1904. No. 60046.

Elevators.

The Control of Electric Elevators (Commande des Ascenseurs Electriques). L. Ramakers. A description of the Siemens-Schuckert system, in which the movement of the car is controlled by push buttons, operated by the passenger without requiring special attendant. 2000 w. Génie Civil—Dec. 19, 1903. No. 60401 D.

Electric Baggage Elevators in the Railway Station at Reichenberg, Bohemia (Elektrische Lastenaufzüge am Banhofe in Reichenberg). W. Krejga. Illustrated description. 1500 m. Zeitschr f Elektrotechnik—Dec. 27, 1903. No. 60446 D.

Induction Motors.

The Choice of Air Gap Diameter for Induction Motors. H. M. Hobart. On induction-motor design, showing the very great percentage which the inductance of the end connections may form of the total inductance, and proposing a method by which the best proportions may be determined. 1000 w. Elec Wld & Engr—Jan. 23, 1904. No. 60372.

Machine Driving.

Electrically-Driven Shops. Report of Committees to Master Mechanics' Assn., giving general review of the systems and methods, with statistics and data derived. 10000 w. Ry & Engng Rev—Dec 19 & 26, 1903. Serial. 2 parts. No. 59936.

The Power Transmission and Speed Control System at the West Allis Works of the Allis-Chalmers Company. An illustrated article describing in detail the application of electric power throughout these large works. 2800 w. Engr, U S A —Jan. 1, 1904. No. 60077 C.

Mine Power.

Application of Electricity in the Anthracite Coal-Field of Pennsylvania, with special reference to the Wyoming Field. Discussion at the Albany meeting of the paper of H. H. Stoek and G. W. Harris. 600 w. Trans Am Inst of Min Engrs—Feb., 1903. No. 60510.

Electric Power in a Lothian Oil Mine Illustrated article describing applications of electric power in Scotland where oil is produced from shale. 2200 w. Elec Rev, N. Y—Jan. 16, 1904. No. 60231.

Printing Office.

The Government Printing Office—The Electrical Equipment of the Largest Printing Office in the World. Illustrated detailed description. 5000 w. Elec Wld & Engr—Jan. 2, 1904. No. 60080.

Pumping.

Belgian Electrical Mine Drainage Installation of the Societe Anonyme des Charbonnage Reunis de la Concorde. Frank C. Perkins. Describes a polyphase installation. 1500 w. Min Rept—Dec. 31, 1903. No. 59984.

Pumping by Electricity. F. H. Pitcher. Gives a brief description of Montreal Water and Power Company's system and growth, and of the electric pumps installed. Ill. 7000 w. Jour N E Water Wks Assn —Dec., 1903. No. 60337 F.

The Electric Pumping Plant of the Neu-Iserlohn II Mine (Die Elektrische Wasserhaltungsanlage auf Zeche Neu-Iserlohn II). H. Schulte. Data and results of tests of 500 h. p. electric pumping plant operating with a total head of 377 metres. 2000 w. Glückauf—Jan. 16, 1904. No. 60469 D.

Regulator.

Routin's Electro-Mechanical Compounding System (Das Elektromechanische Compoundirungssystem von Routin). F. Brock. Description, with diagram, of a system for governing dynamos driven by steam or water, in which the admission valve and the field excitation are simultaneously and instantaneously regulated. 1200 w. Elektrotech Zeitschr—Jan. 14, 1904. No. 60443 B.

New Regulating Arrangements for Direct-Current Electric Motors (Neue Regelungseinrichtungen für Gleichstrom-Elektromotoren). Joseph Löwy. Paper before the Vienna Elektrotechnischer Verein, describing several motor-regulating systems and particularly one due to Josef Seidener, of Vienna. Diagrams. 3000 w. Zeitschr f Elektrotechnik—Dec. 20, 1903. No. 60444 D.

Single Phase.

Single-Phase Alternating-Current Motors, with Commutators (Die Einphasigen Wechselstrom-Kommutatormotoren, deren Entstehung, Arbeitsweise, Regelung und Vergleichende Kritik). M. Osnos. Illustrated comparative discussion of various types of these motors and their operation and regulation. Serial. 2 parts. 7000 w. Elektrotech Zeitschr—Jan. 7 and 14, 1904. No. 60439 each B.

Speed-Torque Characteristics of the Single-Phase Repulsion Motor. Walter I. Slichter. Results of tests of alternating-current motors with armature winding short-circuited on itself through commutator and brushes, which are well suited for railway service. Curve sheets. 1600 w. Trans Am Inst of Elec Engrs—Jan. 29, 1904. No. 60522 D.

The Alternating-Current Railway Motor. Charles P. Steinmetz. Theory of the single-phase repulsion motor, whose field constitutes a primary winding, and whose armature or secondary winding, is closed upon itself through a commutator. Diagrams. 4700 w. Trans Am Inst of Elec Engrs—Jan. 29, 1904. No. 60523 D.

The Alternating-Current Series Motor (Der Wechselstrom-Serienmotor). M. Osnos. Theoretical discussion, with diagrams. 4000 w. Zeitschr f Elektrotechnik —Dec. 27, 1903. No. 60445 D.

See also Street and Electric Railways.

South Africa.

Electricity in the South African Gold Mines. Sidney F. Walker. Describes a gold mine and the applications of electricity being made to its working. 2500 w. Elec Rev, N. Y—Jan. 16, 1904. No. 60232.

Speed Regulation.

Speed Regulation of Direct-Current Motors. H. H. Cutler. Considers the three systems in practical use, their advantages and disadvantages. Ill. 4000 w. Engr, U S A—Jan. 1, 1904. No. 60078 C.

Variable Speed Alternating-Current Motors. Walter I. Slichter. Considers the various types of motors and the methods of controlling them. 2000 w. Engr, U S A—Jan 1, 1904. No. 60079 C.

Steel Works.

Electrical Plant of the Lackawanna Steel Company. Illustrated description of an installation of especial interest in which both direct and alternating current are used. 6500 w. Elec Wld & Engr—Jan. 2, 1904. No. 60082.

TRANSMISSION.

High Tension.

High Tension Continuous-Current Power Transmission at 20,000 Volts. An illustrated article describing an installation for furnishing electric light and power for the Swiss town of Lausanne. 2700 w. Elect'n, Lond—Jan. 1, 1904. No. 60205 A.

Lightning Arresters.

Guard Wires for Transmission Lines. Alton D. Adams. Discusses systems both with and without guard wires, giving information from various sources. Also editorial. 5000 w. Elec Rev, N. Y.—Jan. 16, 1904. No. 60233.

Three-Phase.

Three-Phase Working, with Special Reference to the Dublin System. William Brew. Read before the Dublin Soc. of the Inst. of Elec. Engrs. The present article considers the generating plant. 800 w. Elec Engrs, Lond—Jan. 15, 1904. Serial. 1st part. No. 60388 A.

MISCELLANY.

Charges.

Method of Charging for Electrical Energy. Review of a paper by Ellis H. Crapper before the Leeds Local Sec. of the I. E. E. 1800 w. Elec Rev, Lond—Jan. 1, 1904. No. 60202 A.

Methods of Charging for Electrical Energy. Ellis H. Crapper. Read before the Leeds Sec. of the Inst. of Elec. Engrs. Discusses the nature of the business and the uniform meter rate, &c. 9000 w. Elec Engr, Lond—Jan. 15, 1904. No. 60387 A.

Discoveries.

The New Discoveries in Electricity. Antonia Zimmern. Reviews recent work tending to prove that electricity and light are essentially one, and the discoveries in the field of radio-activity. 4500 w. Nineteenth Cent—Jan., 1904. No. 60216 D.

Laboratories.

The New Electrical Laboratories of the Central Technical College. Joseph Griffin. Illustrated detailed description of a finely equipped laboratory. 1800 w. Elec Engr, Lond—Jan. 1, 1904. No. 60201 A.

Law.

Electrical Law in England and America. A comparison. W. Valentine Ball. 4800 w. Trac & Trans—Jan., 1904. No. 60293 E.

Reviews.

Electrical Progress on the Continent in 1903. Alfred Gradenwitz. A general review of the advance, especially in electric traction. Ill. 3800 w. W Elect'n—Jan. 2, 1904. No. 59959.

The Electrical Industry in Great Britain During 1903. General review. Ill. 4800 w. W Elect'n—Jan. 2, 1904. No. 59958.

GAS WORKS ENGINEERING

Acetylene.

Principle of Acetylene Lamps. S. W. Rushmore. Discusses the principles involved in the operation of an acetylene headlight for automobiles. 1500 w. Automobile—Jan. 2, 1904. No. 59989.

Combined Plant.

A Combined Coal and Water Gas Plant. Illustrates and describes features in Walter R. Jones's patent. 2000 w. Jour Gas Lgt—Dec. 29, 1903. No. 60122 A.

Firebricks.

A New Source of Economy for Gas Works: Firebrick Making at the Crystal Palace District Gas Company's Works. From *Jour of Gas Lgt.* A short illustrated account of what is being done in this line at the works named. 1600 w. Am Gas Lgt Jour—Jan. 25, 1904. No. 60361.

Gaseous Firing.

Notes on Gaseous Firing. J. F. Smith. Read before the Yorkshire Jr. Gas Assn. An illustrated article reviewing the history of gaseous fuel, and the principle upon which gaseous firing is based, its practical working, &c. 7000 w. Am Gas Lgt Jour—Jan. 4, 1904. No. 59994.

Gaseous Fuels.

Gaseous Fuels for Power and Heating. H. Sherwood. A digest of recent knowledge of the use and production of gaseous fuels. 2000 w. Min & Sci Pr—Jan. 16, 1904. Serial. 1st part. No. 60367.

Gas Flow.

The Rational Character of the Experimental Law of Parenty (Rationalité d'une Loi Experimentale de M. Parenty). J. Boussinesq. A study of the agreement of experiment with theory of the flow of gases through orifices. 2500 w. Comptes Rendus—Jan. 4, 1904. No. 60413 D.

Mantle Burners.

Some Speculations on Mantle Burners. Dr. W. H. Birchmore. Discusses details to which inventors must give attention to produce a perfect burner, and the value of a knowledge of the laws of gases. 2800 w. Am Gas Lgt Jour—Jan. 4, 1904. No. 59993.

Producers.

Types of Gas Producers. Prof. A. Humboldt Sexton. Illustrated descriptions of various types. 2000 w. Mech Engr—Jan. 2, 1904. Serial. 1st part. No. 60124 A.

Stray Currents.

See Electrical Engineering, Measurement.

Sulphur.

Utilization of Sulphur in Gas-Works. Discusses old and new methods. 2000 w. Gas Wld—Jan. 16, 1904. No. 60385 A.

Sulphuretted Hydrogen.

Removal of Sulphuretted Hydrogen from Foul Gas Evolved in the Manufacture of Sulphate of Ammonia, Gas Liquors, etc. A report of this system and its advantages. The patent of H. W. Hemingway. 2000 w. Jour Gas Lgt—Dec. 29, 1903. No. 60121 A.

Water Gas.

Notes on the Operation of Large Carburetted Water Gas Sets. Discussion of a paper by W. Cullen Morris. 3000 w. Am Gas Lgt Jour—Dec. 28, 1903. No. 59933.

The Economic Admission of Steam to Water-Gas Producers of the Lowe Type. G. W. M'Kee. Read before the Canadian Soc. of Chem. Ind. Gives an account of experiments conducted in three water-gas machines. 2000 w. Gas Wld—Jan. 9, 1904. No. 60284 A.

INDUSTRIAL ECONOMY

American Trade.

The Development of American Trade. James Dredge. Begins a review of progress, giving diagrams, tables, and information of value. 8200 w. Trac & Trans—Jan., 1904. Serial. 1st part. No. 60291 E.

Apprentices.

The Mechanic of the Future and His Training. E. P. Watson. A comparison of the modern manual-training methods with the older apprenticeship system, showing the necessity for experience in the commercial shop. 4000 w. Engineering Magazine—Feb., 1904. No. 60471 B.

Automobile Industry.

Automobiles vs. Railways and Carriages. Translations from French papers and letters concerning the effect of automobiles on the carriage builders and the passenger business. 2000 w. U S Cons Repts, No. 1843—Jan. 6, 1904. No. 59987 D.

Business.

Business (System des Geschäfts). Alexander Brauner. An address before the Vienna Elektrotechnischer Verein on modern commerce and business and their relations to engineering. 5000 w. Zeitschr f Elektrotechnik—Jan. 10, 1904. No. 60449 D.

Coal Trade.

The Coal Trade of 1903. A review of the past year in the districts of England, Scotland and Wales. 16300 w. Col Guard —Jan. 1, 1904. No. 60126 A.

Coke Trade.

Coke in 1903. E. W. Parker. A record of the work in the principal producing states. 6000 w. Ir Age—Jan. 7, 1904. No. 60049.

Commercial Engineering.

The Commercial Side of Engineering. Walter M. McFarland. Discusses the effect of cost in engineering design, giving illustrations in various fields. 7800 w. Cassier's Mag—Jan., 1904. No. 60273 B.

Copper Industry.

The American Copper Industry. Horace J. Stevens. A review of the past year, the production, prices, &c. 2500 w. Ir Age—Jan. 7, 1904. No. 60052.

Cost Keeping.

The Cost Keeping System of Ludwig Loewe & Co., Berlin (Die Berechnung der Lohnkosten in der Fabrick von Ludwig Loewe & Co. A.-G. in Berlin). M. Chr. Elsner. Giving reproductions of the torms and the methods of using them for obtaining the flat factory cost of manufacture. 2000 w. Zeitschr d Ver Deutscher Ing—Jan. 9, 1904. No. 60422 D.

Education.

Engineering Training and the North-East Coast. Editorial on the work being done by the North-East Coast Institution of Engineers and Shipbuilders. 3000 w. Engng—Jan. 8, 1904. No. 60299 A.

How to Educate an Electrical Engineer. E. Kilburn Scott. An outline of the training necessary, and related matters. 6000 w. Page's Mag—Jan., 1904. No. 60271 B.

Problems for the Engineering School. James B. Stanwood. On the need of more practical education for engineers. 2700 w. Cassier's Mag—Jan., 1904. No. 60276 B.

The Technical High School and the Laboratory Question (Der Technische Hochschul-Unterricht und die Laboratoriumsfrage). Ludwig v. Teknajer. A review of the work of technical instruction in connection with the mechanical laboratory. 5000 w. Zeitschr d Oesterr Ing u Arch Ver—Jan. 8, 1904. No. 60428 D.

Estimates.

The Preparation of Estimates. The first of a series of articles in which it is proposed to analyze the reasons for the great disparity in the estimates given by different firms for the same work, and to study the conditions which would ensure more uniformity. 2800 w. Engr, Lond—Jan. 1, 1904. Serial. 1st part. No. 60129 A.

Iron Ore.

The Lake Ore Trade in 1903. Dwight E. Woodbridge. A review of the year, causes of abatement of demand, disappointment in explorations, shipments, &c. 2000 w. Ir Age—Jan. 7, 1904. No. 60055.

Iron Trade.

A Review of the Southern Iron Trade in 1903. James A. Green. A review by months of the record of the last year. 4400 w. Ir Age—Jan. 7, 1904. No. 60047.

Chicago Iron and Steel Trade in 1903. R. R. Shuman. A review of the past year and the outlook for 1904. 13500 w. Ir Age—Jan. 7, 1904. No. 60054.

Conditions Which Surround the Iron Producer in the United States and Great Britain Compared. George H. Hull. Begins a comparison of the manner of protecting against loss. 5000 w. Ir Age—Jan. 28, 1904—Serial. 1st part. No. 60506.

Iron and Steel in 1903. Frederick Hobart. A review of production, consumption, progress, condition affecting the output, exports and imports, markets, &c. 10500 w. Eng & Min Jour—Jan 7, 1904. No. 60163.

The Philadelphia Iron Trade. Thomas Hobson. A review of the past year and a discussion of the prospects of the ensuing year. 5000 w. Ir Age—Jan. 7, 1904. No. 60051.

The Pittsburgh Iron Trade in 1903. Robert A. Walker. A review of the year, the general features, construction, price agreements, foreign trade, labor troubles, &c., considering also the outlook for 1904. 6500 w. Ir Age—Jan. 7, 1904. No. 60050.

Labor.

A Few Questions to the Rank and File of Laboring Organizations. Discusses points bearing on the motto "Equal Rights for All." 1200 w. Dom Engng—Dec. 25, 1903. No. 59931 C.

Labor Met by Its Own Methods. Isaac F. Marcosson. On the work of the Chicago Employers' Association. 3700 w. World's Work—Jan., 1904. No. 59963 C.

New Phase of the Labor Conflict. Discusses the encouraging outlook from the recent movements of organized employers. 2500 w. Gunton's Mag—Jan., 1904. No. 59962.

Laboratories.

Laboratory vs. Shop. Robert H. Smith.

A reply to a criticism of Prof. M. P. Higgins, explaining the difference between the laboratory method of teaching and the shop method. 2200 w. Am. Mach—Jan. 21, 1904. No. 60312.

Machinery Trade.

New Conditions in the Machinery Business—Must the Locomotive Go? H. H. Lane. Discusses the effect on this business of the use of electric power. 2000 w. Am Mach—Dec. 31, 1903. No. 60001.

Penalties.

The Penalty Clause in Engineering Contracts. W. Valentine Ball. A clear statement of the law relating to penalties, with examples from numerous cases and decisions. 3500 w. Engineering Magazine—Feb., 1904. No. 60476 B.

Persia.

New Highway of Commerce in Persia. Concerning improved facilities for communication and circulation of traffic. 1600 w. U. S. Cons Repts, No. 1841—Jan. 4, 1904. No. 59961 D.

Peru.

Mining and Railway Development in Peru. G. Fred. Collins. A handsomely illustrated account of the country and its commercial possibilities, suggesting the expansion which will follow the opening of the Panama canal. 3000 w. Engineering Magazine—Feb., 1904. No. 60478 B.

Piece Work.

Piece Work, Premium and Bonus Systems. Harrington Emerson. Contribution to the discussion of a paper by Mr. Frank Richards, read at Dec. meeting of the Am. Soc. of Mech. Engrs. 2000 w. R R Gaz—Jan. 15, 1904. No. 60256.

Review.

1903—A Retrospect. Editorial review of the past year in the fields of civil, mechanical, electrical engineering, gas and water supply, chemistry, war material and metallurgy. 28000 w. Engr, Lond—Jan. 1, 1904. No. 60134 A.

Steel Trade.

A Short History of German Dumping. A review of recent events in the iron and steel trade of Germany. 1500 w. Ir & Coal Trds Rev—Jan. 8, 1904. Serial. 1st part. No. 60305 A.

Tin Plates.

An Interesting Year in Tin Plates and Sheets. B. E. V. Luty. A review of the past year, the technical progress, advances, relations with labor, &c. 5000 w. Ir Age—Jan. 7, 1904. No. 60053.

MARINE AND NAVAL ENGINEERING

Battleships.

H. M. S. Hindustan. Illustration, with description of vessel and equipment. 1000 w. Engr, Lond—Jan. 1, 1904. No. 60131 A.

The Chilian Battleship "Libertad." A full illustrated description of this battleship, which was recently purchased by the British Government, including the equipment, armament and report of trials. 20500 w. Engng—Jan. 15, 1904. No. 60501 A.

Cruisers.

New Japanese Armored Cruisers "Kasaga" and "Niasin." Illustrated description of two cruisers built for Argentina, but purchased by Japan. 1000 w. Sci Am—Jan. 23, 1904. No. 60324.

Cunard.

Position of the Cunard Steamship Co. Considers in detail the position of this company which has recently been granted a large subsidy by the British Government. 3000 w. Marine Rev.—Dec. 31, 1903. No. 59988.

Docks.

New Pontoon Dock and Floating Workshop for Natal. Brief illustrated description. 400 w. Sci Am Sup—Jan. 23, 1904. No. 60327.

Ferry House.

New Lackawanna Ferry House at Twenty-third Street, New York. Illustrates and describes a new ferry house to be built at West Twenty-third street, New York. 500 w. R R Gaz—Jan. 15, 1904. No. 60254.

Floating Dock.

The Durban Floating Dock and Workshop. Illustrated description of the 8,500-ton floating dock just completed for this port. 1200 w. Sci Am—Jan. 2, 1904. No. 60073.

Ice Breakers.

Great Lakes Ice-Crushing Car Ferries. An illustrated article giving information concerning the interesting vessels in the service of the great railways, and the conditions they have to conquer. 1800 w. Marine Rev—Jan. 21, 1904. No. 60362 C.

Marine Propulsion.

Marine Propellers with Non-Reversible Engines and Internal Combustion Engines. Rankin Kennedy. Calls attention to other propellers than the screw, and considers various methods of employing the screw propeller. Ill. 4700 w. Trans Inst of Engrs and Shipbuilders—Nov. 24, 1903. No. 59951 D.

Railroad Ferry.

Steam Railroad Ferry Between Gjedser and Warnemuende. Illustrations, with description, of the two large ferryboats of the Mecklenburg government, used for transferring cars between the points named. 1000 w. Sci Am Sup—Jan. 9, 1904. No. 60136.

Sailing Vessels.

The Rigging of American Sailing Vessels. Fred. M. Cook. Illustrates and describes various rigs used for sailing vessels. 2500 w. Marine Engng—Jan., 1904. No. 60100 C.

Salving.

Salving the Hutchinson. An illustrated account of a remarkable rescue of a vessel on the Great Lakes. 3000 w. Marine Rev—Dec. 24, 1903. No. 59930.

Shipbuilding.

Shipbuilding and Marine Engineering, 1903. Begins a review of the year just ended. 4000 w. Engng—Jan. 1, 1904. Serial. 1st part. No. 60210 A.

Shipyards.

Shipyard Economies. R. S. Hubbard. Considers the practical economies of ship construction under the headings of labor, labor control, organization, plant and materials. 3400 w. Marine Engng—Jan., 1904. Serial. 1st part. No. 60101 C.

Speed Launches.

Engineering a High-Speed Launch. Herbert L. Towle. A non-technical explanation of the process by which motors of unusual power have been developed for boat use. 2000 w. Automobile—Jan. 2, 1904. No. 59990.

Submarine.

Early Attempts at Submarine Navigation. Notes from a recent work by Alan H. Burgoyne, giving particulars of the work of early inventors in this field. 1800 w. Sci Am Sup—Jan. 9, 1904. No. 60137.

The Lake Submarine Torpedo Boat "Protector." An illustrated article outlining the main features of this boat. 2500 w. Sci Am—Dec. 26, 1003. No. 59943.

Tug.

Twin-Screw Tug for the Isle of Wight Steam-Packet Company. Illustrated description of a tug which can also be used for salvage purposes and for extinguishing fires. 300 w. Engng—Jan. 1, 1904. No. 60211 A.

MECHANICAL ENGINEERING

AUTOMOBILES.

Accumulators.

Useful Hints and Tips on Recharging Accumulators. Deals with method, cost, and current taken in the present number. 900 w. Autocar—Dec. 26, 1903. Serial. 1st part. No. 60114 A.

Aluminum Bodies.

Rushing Metal Body Work on Show Cars. An illustrated article describing the rapid work done in some of the factories in making aluminum bodies for the cars to be on exhibition at Chicago and New York. 3000 w. Automobile—Jan. 16, 1904. No. 60219.

Automobile Industry.

See Industrial Economy.

Carburation

The Principles of Automatic Carburation. Translation of an article from the French by Henri Walcker. 2500 w. Autocar—Jan. 9, 1904. No. 60280 A.

Carbureters.

Some 1904 French Carbureters. Ed. Vrard, in *La Vie Automobile*. Illustrates and describes some inproved types exhibited at the Paris show. 1000 w. Automobile—Jan. 16, 1904. No. 60221.

The Prunel Automatic Carburettor. Illustrated description of a small bicycle type carburettor recently brought out. 1200 w. Auto Jour—Jan. 2, 1904. No. 60198 A.

Fuel.

Benzol as a Motor Fuel. Discusses the nature of benzol, its efficiency, advantages, &c. 2800 w. Autocar—Jan. 16, 1904. No. 60381 A.

Manufacture.

The Manufacture of Automobiles. An illustrated description of interesting features of manufacture as carried out in the plants at Detroit and Lansing, Mich., of the Olds Motor Works. 1400 w. Sci Am—Jan. 9, 1904. No. 60135.

Military Tractor.

A Triumph for Heavy Oil. Illustrates and describes the Hornsby heavy oil military tractor, giving facts in regard to its operation, and the conditions it was required to meet. 2000 w. Auto Jour—Jan. 9, 1904. No. 60279 A.

Motor Cars.

The Hallamshire Cars. Illustrates and describes details of one of these cars. 1000 w. Autocar—Jan., 1904. No. 60115 A.

Motors.

The Petrol Engine—Its Working Explained. A simple illustrated description of the working of the petrol motor. 1000 w. Autocar—Jan. 2, 1904. No. 60125 A.

The Selbach "Single-Valve" Petrol Motor. Brief illustrated description of an engine having a combined inlet and exhaust valve, which is operated by one cam, and is fitted into the cylinder head. 800 w. Auto Jour—Dec. 26, 1903. No. 60116 A.

New York Show.

Tendencies Embodied in the Exhibits. Hugh Dolnar. Review of the 1904 New York Show, calling attention to the developments of the past year and noting the present tendencies. 3000 w. Automobile Jan. 23, 1904. No. 60517.

The Show an Educational Treat. An illustrated account of the exhibits at the 1904 show in New York. 1500 w. Automobile—Jan. 23, 1904. No. 60515.

Operation.

Convenience in Operation. Rene M. Petard. Calls attention to minor details appreciated by the users of cars. 2000 w. Automobile—Jan. 23, 1904. No. 60516.

Petrol Cars.

The Brouhot Petrol Cars. Illustrates and describes the latest 4-cylinder models. 1400 w. Auto Jour—Jan. 16, 1904. No. 60383 A.

The Hotchkiss 20 H. P. Petrol Car. Illustrated description of a car exhibited in Paris. 800 w. Auto Jour—Jan. 9, 1904. No. 60278 A.

The Motobloc Petrol Car. Illustrated description of a 10 h. p. car. 1000 w. Auto Jour—Jan. 16, 1904. No. 60384 A.

The 1904 Cottereau Petrol Cars. Illustrated detailed description of a 3-cylinder 12 to 16 h. p. vehicle with new features. 2000 w. Auto Jour—Jan. 16, 1904. No. 60382 A.

The Spyker Petrol Cars. Illustrates and describes recent designs of these touring cars. 1800 w. Auto Jour—Jan. 2, 1904. No. 60197 A.

Road Traction.

The Continuous Automobile Train (Le Train Automobile à Propulsion Continue). Col. G. Espitallier. An illustrated description of the Renard train, in which the power is transmitted by shafting with universal joints, through the whole train. 2500 w. 1 plate. Génie Civil—Dec. 19, 1903. No. 60400 D.

Reliability Trial.

An Alpine Automobile Reliability Trial. From *The Car*. An account of a trip in a Martini car up and down Rochers de Naye, in Switzerland. Ill. 2000 w. Sci Am Sup—Dec. 26, 1903. No. 59946.

Steam Cars.

A Substantial Steam Car. Illustrated description of the Simpson cars. Pleasure vehicles of 6 or 12 h. p., a simple type of engine, steam supplied by a flash generator heated by a paraffine burner. 1500 w. Autocar—Jan. 16, 1904. No. 60380 A.

Features of Four-Cylinder Locomobile. Illustrates and describes details of this four-cylinder touring car, showing recent improvements. 2000 w. Automobile—Dec. 26, 1903. No. 59929.

Touring Cars.

Pierce Four-Cylinder Touring Car. Description of a modern multi-cylinder car with reproduction of factory blue-prints. 2000 w. Automobile—Jan. 16, 1904. No. 60220.

The Thomas 3-Cylinder Touring Car. Illustrated description of a new model. 1200 w. Automobile—Jan. 9, 1904. No. 60166.

HYDRAULICS.

Drainage.

Water Supply and Drainage Systems in the Lorraine Hotel, New York. Illustrates and describes interesting details of systems used in a thirteen-story apartment hotel. 2500 w. Eng Rec—Jan. 9, 1904. No. 60189.

Electric Pumping.

See Electrical Engineering, Power Applications.

Hydraulic Power.

Hydraulic Power in Foundry and Machine Shop. Joseph Horner. An illustrated article on the advantages of an hydraulic installation, the uses to which the power is applied, types of hydraulic machinery, &c. 6600 w. Cassier's Mag—Jan., 1904. No. 60274 B.

Hydro-Electro Stations.

See Electrical Engineering. Generating Stations.

Power Plant.

The Steam Hydraulic Plant of the Virginia Passenger & Power Company, Richmond, Va. Illustrated description of new features introduced in this enlarged plant, especially the new type of dam, and a rack-cleaning mechanism for clearing the intakes of obstructions. 2500 w. Eng Rec—Jan. 2, 1904. No. 60060.

Turbines.

Great Modern Turbine Installations. (Grosse Moderne Turbinenanlagen). L. Zodel. With especial reference to the work of Escher, Wyss & Co., including the plant of the Canadian Niagara Falls Power Company. Serial. Part I. 3000 w. Schweiz Bauzeitung—Jan. 2, 1904. No. 60458 B.

MACHINE WORKS AND FOUNDRIES.

Boiler Tubes.

Manufacture of Seamless Cold-Drawn Steel Boiler Tubes. G. M. Kohler. Description of the process. Ill. 1700 w. Marine Engng—Jan., 1904. No. 60103 C.

Boring Tools.

A Spherical Boring Tool for the Drill Press. Louis W. G. Flynt. Illustrated description of a tool designed for the purpose of boring spherical holes in the ends of connecting rods. 1200 w. Am. Mach —Jan. 7, 1904. No. 60097.

Brass Furnaces.

The Wever Triplex Brass Furnace. Paul Wever. An illustrated description. 2000 w. Foundry—Jan., 1904. No. 59967.

Cable Works.

Messrs., W. T. Glover & Co.'s Cable Works, Manchester. Illustrated detailed description of extensive works for the manufacture of conductors of various descriptions. 6300 w. Engng—Jan. 1, 1904. No. 60208 A.

Cranes.

50-Ton Hydro-Electric Overhead Crane. Illustration, with brief description of cranes in use at Swindon. 350 w. Engr, Lond— Dec. 25 1903. No. 59082 A..

Some Recent Examples of German Crane Construction. Illustrates and describes wharf cranes, revolving cranes, derrick, hammer and other types. 2800 w. Ir and Coal Trds Rev—Dec. 25, 1903. No. 60120 A.

The Development of Crane Building in Germany (Die Entwicklung des Kranbaues in Deutschland). Heinr. Rupprecht. Showing how the use of English-built cranes in Germany has been largely superseded by machines of German design and construction. 2500 w. Oesterr Zeitschr f Berg u Hüttenwesen—Dec. 12, 1903. No. 60461 D.

Travelling Inverted Pillar Crane. Illustrated description of a new form of crane with novel features. 1000 w. Engr, Lond—Jan. 15, 1904. No. 60397 A.

See Electrical Engineering. Power Applications.

Crankshafts.

The Machining of Multiple-Throw Crankshafts. Illustrated description of the Tindel-Albrecht crankshaft lathe and its operation. 1000 w. Am Mach—Jan. 14, 1904. No. 60229.

The Machining of Single-Throw Crankshafts. Illustrates and describes special tools used for this work. 600 w. Am Mach—Jan. 7, 1904. No. 60095.

Die-Cutting.

Machines and Tools Employed for Die-Cutting. Joseph Horner. The first of a series of articles on machines for cutting forging dies. Ill. 2500 w. Engng—Jan. 1, 1904. Serial. 1st part. No. 60209 A.

Dies.

Bolt Heading Dies. Thomas Beasley. Directions for the making of these dies. 1400 w. Am Mach—Jan. 7, 1904. No. 60096.

Drawing Press.

The Adriance New Style Drawing Press. Illustrated description of features of this machine, intended for general drawing work. 1800 w. Ir Age—Jan. 21, 1904. No. 60310.

Electric Driving.

See Electrical Engineering, Power Applications.

Engine Building.

Modernization in Engine Building. Illustrated description of special tools used in the new plant of the Hooven-Owens-Rentschler Company. 3800 w. Ir Age—Jan. 7, 1904. No. 60041.

Engine Works.

The New Hamilton-Corliss Engine Works. An illustrated description of the rebuilt and greatly enlarged shops of the Hooven, Owens & Rentschler Co. at Hamilton, Ohio. 2500 w. Mach, N. Y.—Jan., 1904. No. 60056 C.

Gauges.

Gauges. Joseph M. Stabel. Discusses the construction of gauges, showing several styles and their uses. Ill. 1200 w. Am Mach—Jan. 14, 1904. No. 60230.

Grinding.

Grinding. Hints from an operator of experience. 3200 w. Am Mach—Jan. 21. 1904. No. 60314.

Points on Grinding. C. H. Norton. Gives a short study of the evolution of the grinding wheel and the grinding machine, and discusses the cause of chatters and troubles in rapid grinding. 2500 w. Am Mach—Jan. 7, 1904. Serial. 1st part. No. 60099.

Recent Progress in Cylindrical Grinding. C. H. Norton. On the rapid progress in this work during the last few years. 1500 w. Ir Age—Jan. 7, 1904. No. 60045.

The Norton New 14-Foot Grinding Machine. Illustrated description of this machine and its manipulation. 2800 w. Ir Age—Jan. 28, 1904. No. 60503.

Lathe.

An English Turret Lathe. Illustrated description of a lathe for general shop purposes, especially for handling bar work and castings and forgings. 800 w. Am Mach—Jan. 14, 1904. No. 60227.

Machine Rating.

Plan to establish a Machine Rating in a

Locomotive Machine Shop, with Special Reference to New Tools. J. F. De Voy. Explains a system of card rating giving information relative to the number of cuts, length of time and movement of work to be performed. General discussion. 7500 w. Pro W Ry Club—Dec. 15, 1903. No. 60331 C.

Machinery Trade.

See Industrial Economy.

Machine Tools.

Machine Tools and High Speed Steel. J. A. Carney. Considers the question of what shall be done with serviceable machines which cannot keep up with the high speed steel pace. General discussion. 4000 w. Pro W. Ry Club—Dec. 15, 1903. No. 60332 C.

Metal Drawing.

Drawn Bars of Round and Rectangular Sections. Amos Price. An illustrated description of the way round and other bars are made. 1500 w. Am Mach—Jan. 21, 1904. No. 60315.

Milling.

Some Milling Operations. A series of illustrations of rigs and fixtures for performing milling operations. 1500 w. Engr., Lond—Jan. 15, 1904. No. 60398 A.

Molding.

Molding a Slewing Crane Girder. Joseph G. Horner. Illustrates and describes the making of a large casting. 1500 w. Am Mach—Jan. 7, 1904. No. 60098.

Stripping Plates. P. R. Ramp. An illustrated article describing method of greatly reducing the cost of this work. 800 w. Foundry—Jan., 1904. No. 59968.

Planer Work.

Special Tools for Rapid Planer Work. E. E. Wood. Illustrates and describes devices for the rapid planing of lathe beds. 800 w. Am Mach—Jan. 14, 1904. No. 60226.

Pump Works.

The New Worthington Hydraulic Works at Harrison, N. J. Explains considerations that led to the removal of this plant from Brooklyn, and gives an illustrated detailed description of the new works. 2000 w. Eng News—Dec. 31, 1903. No. 60030.

Rapid Machining.

Rapid Machining of Crank Shafts. An illustrated article describing advanced methods employed at the Eddystone Works of the Tindel-Morris Company. 1700 w. Ir Age—Jan. 7, 1904. Serial. 1st part. No. 60042.

Rigs.

Arc Milling and Boring Rings. Gustave Fiedler. Illustrates and describes method adopted in doing work where convenient tools were wanting. 600 w. Am Mach—Jan. 14, 1904. No. 60228.

Running Fits.

Running Fit Limits. Henry Hess. Gives diagram and explanation of limits found to be well adapted to the manufacture of medium and heavy machine tools. 500 w. Am Mach—Jan. 21, 1904. No. 60311.

Saving Methods.

The Saving Methods for the Machine Shop. Frank F. Kleinhans. Describes a fixture for milling tool post wedges, the finishing up work from the screw machine; and a fixture for milling square head screws. Ill. 1400 w. Ir Trd Rev—Jan 7, 1904. No. 60087.

Sheet Metal.

Manufacturing Sheet Metal Shovel Handle. W. W. Patterson. Illustrated description of a difficult piece of work. 1000 w. Am Mach—Dec. 31, 1903. No. 60002.

Steam Turbine Discs.

The Design of Steam Turbine Discs. Frank Foster. A mathematical method for designing a wheel or disc capable of a very high speed of rotation. 1200 w. Engr, Lond—Jan. 8, 1904. No. 60304 A.

MATERIALS OF CONSTRUCTION.

Alloys.

Aluminum Bronze for Small Work. Walter J. May. Suggestions for making alloys that will give good results. 1000 w. Prac Engr—Jan. 1, 1904. No. 60196 A.

Iron and Steel Alloys. R. A. Hadfield. On the effect of various elements upon iron. 5200 w. Iron and Steel Met—Jan., 1904. No. 60347 D.

Cast Iron.

A Problem in the Metallurgy of Cast Iron. Dr. Richard Moldenke. How to overcome the dissolved oxide of iron found in the pig and scrap is discussed, and other difficulties. 1200 w. Ir and Steel Met—Jan., 1904. No. 60349 D.

Note on the Further Discussion of the Physics of Cast-Iron. William R. Webster. A list of the contributions to the *Transactions* bearing on this subject, since 1895. 600 w. Trans Am Inst of Min Engrs—Feb., 1904. No. 60514.

The Molecular Mobility of Cast Iron. Describes investigations made by Mr. Alexander E. Outerbridge on cast and wrought iron subject to reneated heating and cooling. 4000 w. Ill. Engng—Jan. 8, 1904. No. 60300 A.

Physical Structure.

The Physical Structure of Metals and

Alloys. J. J. Kessler, Jr. A brief illustrated study. 1500 w. Jour Assn of Engng Socs—Dec., 1903. No. 60343 C.

Steel.

Sixth Report to the Alloys Research Committee on the Heat Treatment of Steel. Sir William C. Roberts-Austen and Prof. William Gowland. 39 plates. 28 tables. 26800 w. Inst of Mech Engrs—Jan. 15, 1904. No. 60392 D.

Testing.

The Efforts Developed in Drop Testing Nicked Bars (Sur les Efforts Développés dans le Choc d'Eprovettes Entaillées). A. Pérot. Describing a device which draws automatic records of the forces exerted by a drop upon a test specimen. 800 w. Comptes Rendus—Dec. 14, 1903. No. 60412 D.

Tool Steels.

American Tests of Rapid Cutting Tool Steels. A report of tests made by the Lodge & Shipley Machine Tool Co. of Cincinnati, O. 2400 w. Ir Age—Dec. 31, 1903. No. 59997.

Wrought Iron.

Structural Changes in Wrought Iron. H. Stillman. Relates only to manufactured, rolled, or what is commercially known as fibrous wrought iron, giving reports of tests and results. Discussion. Ills. 10500 w. Pro Pacific Ry Club—Nov. 21, 1903. No. 59953 C.

MEASUREMENT.

Air Friction.

Preliminary Experiments on Air Friction. W. Odell. Read at Southport, before the British Assn. Gives an account of attempts to measure the power required to keep a plane circular disc rotating. 5000 w. Engng—Jan. 1, 1904. No. 60214 A.

Dynamometric Fan.

The Renard Dynamometric Fan for Measuring the Power of Gasoline Motors. Translated from *L'Automobile,* with an excerpt from the *Horseless Age*. Illustrated detailed description. 2800 w. Sci Am Sup—Dec. 26, 1903. No. 59947.

Heat Gauge.

The Morse Heat Gauge. Report of the Committee on Science and the Arts on the invention of Everett F. Morse. Ill. 1400 w. Jour Fr Inst—Jan., 1904. No. 60334 D.

Screw Threads.

A Microscope for Measuring Screw Threads. Illustrated description of instrument. 700 w. Am Mach—Jan. 21, 1904. No. 60313.

Measuring External Thread Diameters. Joseph M. Stabel. Describes a method of thread measurement by means of wires and micrometers, giving tables. 1600 w. Mach, N. Y.—Jan, 1904. No. 60057 C.

POWER AND TRANSMISSION.

Air Compressor.

Tests of the Köster Air Compressor (Mitteilungen über Versuche an einem Luft Kompressor mit Köstersteuerung). H. Terbeck. Tests of a compressor with mechanically operated valves, with indicator diagrams showing the valve action and efficiency. 5000 w. 1 plate. Glückauf—Jan. 2, 1904. No. 60467 D.

Apartment Houses.

The Power Plant and Mechanical Equipment of Apartment Houses. P. R. Moses. An account of the heating, lighting, refrigerating and general power and mechanical equipment of the large apartment house in America. 5000 w. Engineering Magazine—Feb., 1904. No. 60472 B.

Color Works.

The Machinery Plant of the New Leverkusen Color Works (Die Maschineneinrichtung des Neuen Werkes Leverkusen der Farbenfabriken vorm. Friedrich Bayer & Co. in Elberfeld). Describing especially the pumping machinery and the power plant. 4000 w. 2 plates. Zeitsch d Ver Deutscher Ing—Jan. 2, 1904. No. 60416 D.

Conveyors.

Conveyors and Ore Handling Appliances of the Iron Works at Elba (Transporteur Aerien et Grues de Déchargement de l'Usine Métallurgique d'Elba). E. Boucher. Illustrating the conveyors used on the docks at Elba for handling ore and coal. 1800 w. 1 plate. Génie Civil—Jan. 9, 1904. No. 60407 D.

Conveyors in Modern British Power Houses. Arch. J. S. B. Little. Describes improved methods of transporting materials in large power houses. Ill. 2000 w. St Ry Jour—Jan. 2, 1904. No. 60019 C.

Fuel Handling Machinery. Philip Dawson. An illustrated detailed description of machines and apparatus for mechanical handling. 4600 w. Trac & Trans—Jan. 1904. Serial. 1st part. No. 60295 E.

Modern Hoisting and Conveying Apparatus for Workshops (Moderne Hebe und Transportvorrichtungen für Hüttenwerke). H. Rupprecht. A review of modern cranes, cableways, bucket conveyors, etc., as applied to manufacturing establishments. Serial, Part I. 1000 w. Oesterr Zeitschr f Berg u Hüttenwesen—Jan. 2, 1904. No. 60465 D.

Haulage.

Cable Haulage for Transporting Marl to the Mills of the Bronson Portland Cement

Co. Illustrated description of a haulage plant which works successfully from marl beds to mills, located at Bronson, Mich. 1500 w. Eng News—Jan. 21, 1904. No. 60318.

Speeds.

The Design of Speed Cones, Gears, &c., for Machine Tools. W. Owen. Shows how to give speeds in geometrical progression. Gives diagram for calculations, explaining its use. 1800 w. Mech Engr—Jan. 9, 1904. No. 60283 A.

SPECIAL MOTORS.

Alcohol.

Mechanical and Commercial Aspects of the Alcohol Motor. Henri Dupays. With numerous illustrations showing the use of alcohol in internal-combustion motors, and data and results of tests. 3500 w. Engineering Magazine—Feb., 1904. No. 60475 B.

Combustion Motors.

Lines of Progress in the Efficiency of the Combustion Motor. E. C. Warren. A discussion of the practicability of the constant pressure generator, and its applicability for driving rotary and other motors. 3500 w. Engineering Magazine—Feb., 1904. No. 60477 B.

Gas Engines.

The Gas Engine Situation in Europe. G. L. Carden. Brief descriptions of some of the high-power gas engines being made in Germany. Ill. 1500 w. Am Elect'n—Jan., 1904. No. 60106.

The Oechelhauser Gas Motor. A. Borsig. An illustrated detailed description of W. von Oechelhauser's two-stroke cycle motor. 1100 w. Am Elect'n—Jan., 1904. No. 60107.

The Vogt Gas-Engine. Herbert A. Humphrey. Illustrated description of a design of Adolf Vogt, and its working. 4200 w. Engng—Jan. 8, 1904. No. 60297 A.

Gasoline Motor.

Design for a Gasoline Motor. J. C. Brocksmith. Drawings and description of a high-speed enclosed crank-case type, used in automobile work and also for stationary purposes. 2000 w. Am Elect'n—Jan., 1904. No. 60110.

Gas Power.

Blast Furnace Gas as a Source of Power. An account, with illustrations, of the system developed by B. H. Thwaite, with letters in regard to reliability of the apparatus. 3000 w. Power—Jan., 1904. No. 60008 C.

Internal Combustion.

A Compression Combustion Motor (Moteur à Combustion par Compression). M. Cannevel. Describing a design for a gas or petroleum engine with compression ignition. 800 w. Comptes Rendus—Dec. 14, 1903. No. 60411 D.

American Internal Combustion Engines. An illustrated review of American gas and oil engine design. 12500 w. Am Elect'n—Jan., 1904. No. 60109.

STEAM ENGINEERING.

Boilers.

The Formula Used in Rules for the Inspection of Steam Boilers in British Columbia. J. A. Crawford. A criticism of the formulæ in these rules, pointing out inaccuracies. 1500 w. B C Min Rec—Jan., 1904. No. 60218 B.

The Inspection and Care of Steam Boilers. The first of a series of articles dealing with boiler inspector's work, defects, conditions of working, piping, &c., &c. 2200 w. Mech Engr—Jan. 2, 1904. Serial. 1st part. No. 60123 A.

Condensers.

Central Condensing Systems. Louis R. Alberger. An illustrated detailed description of this system. 2200 w. Ir Age—Jan. 7, 1904. No. 60043.

The Condenser Plant at Glasgow Electric Power Station. Illustrated description. 1000 w. Power—Jan., 1904. No. 60009 C.

Tubing a Condenser. Joseph G. Horner. Illustrates and describes a method of tubing a surface condenser made for a small horizontal engine. 600 w. Am Mach—Dec. 31, 1903. No. 60000.

Engines.

When an Engine Becomes a Pump. W. H. Wakeman. Describes conditions that make this possible. 1600 w. Elec, N. Y—Jan. 6, 1904. No. 60038.

Heat Transference.

Heat Transference Through Boiler-Plates. From *Zeitschrift des Vereins Deutscher Ingenieure.* An account of researches, giving diagrams. 2000 w. Engng—Jan. 1, 1904. No. 60207 A.

Large Units.

Problems in the Designing of Large Steam Units. Discusses modern methods and the enormous units in engines and turbines, considering especially boilers and superheaters and their limitations. 1800 w. Ir Age—Jan. 7, 1904. No. 60044.

Mechanical Stokers.

The Failure of Mechanical Stokers in India. Information from the report of Mr. Frederick Groves, as to the causes of the failure of types used in India. 1100 w. Engr, Lond—Jan. 1, 1904. No. 60133 A.

Oil Burning.

Oil Burning Utilities and Futilities.

Amanda T. Jones. Reviews the tables of the Naval Bureau's Liquid Fuel Board, and gives the writer's conclusions. 2600 w. Engr, U S A—Jan. 15, 1904. No. 60269 C.

Smoke Prevention.

Smoke Prevention by Admission of Air Above the Fire (Rauchvermeidung durch Zuführung von Luft ueber dem Feuer). A. Dosch. With illustration of a form of grate adapted to admit heated air to aid in the combustion of the gases. 2500 w. Zeitschr d Oesterr Ing u Arch Ver—Jan. 1, 1904. No. 60426 D.

Steam Turbines.

High Power Westinghouse-Parsons Steam Turbines. Illustrated description of a 5000-kilowatt turbo-generating unit of extreme compactness. 2000 w. Eng Rec.—Jan. 2 1904. No. 60064.

Superheating.

Comparative Experiments with Saturated and Moderately Superheated Steam in Locomotives (Vergleichende Versuche mit Gesättigtem und Mässig Ueberhitztem Dampf au Lokomotiven). H. Strahl. Data and results of tests on the Prussian State Railways, showing fuel economies of 10 to 12 per cent. by superheating. 5000 w. Zeitschr d Ver Deutscher Ing—Jan. 2, 1904. No. 60418 D.

Superheated Steam. F. J. Rowan. Discussion of this paper. Ill. 4700 w. Trans Inst of Engrs & Shipbuilders—Nov. 24, 1903. No. 59949 D.

Superheated Steam for Steam Engines. Bryan Donkin. An illustrated article considering a number of types of superheaters and giving facts in regard to the Schmidt system. 2400 w. Cassier's Mag—Jan,, 1904. No. 60275 B.

The Specific Heat of Superheated Steam (Ueber die Spezifischen Wärmen des Ueberhitzten Wasserdampfes). Dr. Weyrauch. An exhaustive examination of the relation of the specific heat of steam to temperature and pressure, with formulas and tables for its determination. Two articles. 5000 w. Zeitschr d Ver Deutschr Ing—Jan. 2, 9, 1904. No. 60419 each D.

The Total Heat of Superheated Steam (Die Erzeugungswärme des Ueberhitzten Wasserdampfes). Dr. A. Griessmann. An experimental study of the properties of superheated steam, with especial reference to the specific heat at various temperatures. Two articles. 7500 w. Zeitschr d Ver Deutscher Ing—Dec. 19, 26, 1903. No. 60415 each D.

The Use of Superheated Steam. Prof. Storm Bull. Reviews the history of its use, and describes the arrangements of superheater, with respect to the boiler, the difficulties, with tests of engines under superheated steam, various types, &c. General discussion. 10500 w. Jour W Soc of Engrs—Dec., 1903. No. 60342 D.

Valve Gears.

Duplex Valve Gear, London and North-Western Railway. Illustrated description, with diagrams, of Whale's valve gear. 500 w. Engr. Lond—Jan. 8, 1904. No. 60303 A.

Improvements in Valve-Gears. John Riekie. Discussion of this paper. 2700 w. Trans Inst of Engrs and Shipbuilders—Nov. 24, 1903. No. 59950 D.

Valves.

Suyden's Combined Stop and Isolating Valve. Illustrates and describes a valve which closes automatically in both directions in case of accident. 1200 w. Engng—Jan 1, 1904. No. 60213 A.

Reducing Valves. R. T. Strohm. Gives illustrated description of the construction and operation of three different types of reducing valves. 1800 w. Am Elect'n—Jan., 1904. No. 60113.

Water-Softeners.

An inquiry into the Working of Various Water-Softeners. C. E. Stromeyer and W. B. Baron. Explains the behavior of various impurities, the difficulties to be overcome, and gives illustrated descriptions of many water-softeners, showing the suitability of the various types for special purposes. 16200 w. Inst of Mech Engrs—Dec. 18, 1903. No. 59948 D.

MISCELLANY.

Aeronautics.

Recent Progress in the Construction of Air Ships (Die Neueren Versuche über die Fortbewegung von Luftschiffen). Col. Buchholtz. With special reference to the recent dirigible balloons of Santos-Dumont, Severo, Bradsky and Lebaudy. 3000 w. Glasers Annalen—Jan. 15, 1904. No. 60455 D.

The Barton 150 Horse-power Airship's Forthcoming Trial. Illustrates and describes novel features of the improved airships. 1800 w. Sci Am—Jan. 16. 1904. No. 60247.

The Possibility of Sustaining a Flying Machine in the Air (Sur la Possibilité de Soutenur en l'Air un Appareil Volant). Ch. Renard. A discussion of the practicability of using screw propellers to lift a machine in the air, using motors of existing weight and power. 1000 w. Comptes Rendus—Nov. 23, 1903. No. 60409 D.

The Properties of Self-Supporting Propellers (Sur la Qualité des Hélices Sustentatrices). Ch. Renard. A discussion of the design and proportions of screw propellers of aerial support and propulsion. 1200 w. Comptes Rendus—Dec. 7. 1903. No. 60410 D.

The Dirigible Balloon "Ville de Paris" (Le Dirigeable "La Ville de Paris"). Col. G. Espitallier. A description of the large dirigible balloon recently built for M. Deutsch in Paris by M. Victor Tatin. The gas bag is 58 metres long and 8.20 metres diameter, and the motor is of 63 horsepower. 1800 w. Génie Civil—Dec. 26, 1903. No. 60404 D.

Heating.

A New System of Hot-Water Heating. Illustrates and describes a quick circulating hot-water heating system having new and interesting features; developed by a firm in Vienna, Austria. 2300 w. Met Work—Jan. 2, 1904. No. 60013.

Low Pressure Hot Water Heating on the Reck Circulator System. C. I. Haden. Read in London, at meeting of the Inst. of Heat. and Ven. Engrs. An illustrated description of the apparatus of a system largely used on the Continent. 5400 w. Dom Engng—Dec. 25, 1903. No. 59932 C.

The Battery System of Warm Air Heating. C. E. Oldacre. Read at N. Y. meeting of Am. Soc. of Heat. and Ven. Engrs. Illustrated description of an installation in a suburban house. 2500 w. Met Work—Jan. 23, 1904. No. 60350.

Mechanical Plant.

Ventilation and Heating in the Penobscot County Court House, Bangor, Maine. Explains the requirements and the scheme adopted. Ill. 1800 w. Eng. Rec—Jan 2, 1904. No. 60065.

Moisture.

The Necessity of Moisture in Heated Houses. R. C. Carpenter. Read at N. Y. meeting of Am. Soc. of Heat. and Ven. Engrs. On the effects of dry air and means of maintaining a constant degree of humidity. 2500 w. Met Work—Jan. 23, 1904. No. 60351.

Temperature.

The Temperature of Flames (Sur la Temperature des Flammes). Ch. Féry. Giving the results of recent determinations of the temperatures of flames of illuminating gas, in various fumers, hydrogen, acetylene, etc., by a new spectroscopic method. 1500 w. Comptes Rendus—Nov. 30, 1903. No. 60408 D.

MINING AND METALLURGY

COAL AND COKE.

Coal Trade.

See Industrial Economy.

Collieries.

The Mechanical Engineering of Collieries. T. Campbell Futers. The present article is introductory to a discussion of the mechanical engineering of modern mines, with all the recent improvements, and also of the yet unsolved problems. 1000 w. Col Guard—Jan. 1, 1904. Serial. 1st part. No. 60127 A.

Colorado.

The Book Cliff Coal Mines. Prof. Arthur Lakes. Illustrated description of coal seams near Grand Junction, Colorado, which exhibit interesting peculiarities in their locations and formations. 2500 w. Mines & Min—Jan., 1904. No. 60007 C.

The Development of a New Coal Field in Colorado. L. B. Merriam. Describes coal development work at Tercio, Cúatro, and vicinity. 7000 w. Jour W Soc of Engrs—Dec., 1903. No. 60339 D.

The Yampa Coal Fields. Prof. Arthur Lakes. An illustrated description of the anthracite, bituminous and lignite field traversed by the Moffat road in Routt County, Colorado. 1800 w. Mines & Min—Jan., 1904. No. 60004 C.

Coke Trade.

See Industrial Economy.

Peat.

Peat as an Article of Fuel. Extracts from a paper by J. Campbell Morrison, read before the Robert Fulton Assn., of the Nat. Assn of Engrs. Gives information of intérest and describes the three most successful systems of making peat briquettes. 2500 w. Am. Archt—Dec. 26, 1903. No. 59937.

Review.

Coal in 1903. Samuel Sanford. Reviews the developments of the principal coal fields of the world during the last year. Also brief reports from various districts in the United States. 8500 w. Eng & Min Jour—Jan. 7, 1904. No. 60164.

Washing.

Coal Screening and Washing Plant at a German Colliery. Illustrated detailed description of a plant at the Dahlbusch Colliery. 1600 w. Col Guard—Jan. 8, 1904. No. 60296 A.

COPPER.

Converter Process.

Smelting Copper by the Converter Process (Die Kupfergewinnung mit Hilfe des Konverter-Prozesses). Gustav Kroupa. A review of the experience with the converter in copper smelting, with an examination of the chemical reactions. Two articles. 4000 w. Oesterr Zeitschr f Berg u Hüttenwesen—Dec. 12, 19, 1903. No. 60-460 each D.

Copper Industry.

See Industrial Economy.

Deposits.

Cananea Revisited. Robert T. Hill. Describes the geography, geology and copper deposits of these mountains on the Mexican border of Arizona. 8000 w. Eng and Min Jour—Dec. 31 1903. No. 60022.

Copper Deposits at Clifton, Arizona. From Waldemar Lindgren's contribution to the United States geological survey. Describes the geological features and the deposits. 2500 w. Min Rept—Dec. 31, 1903. No. 59985.

The Geology and Copper-Deposits of Bisbee, Arizona. F. L. Ransome. Abstract of an official report of a detailed geological study of this region. Ill. 7500 w. Trans Am Inst of Min Engrs—Feb., 1903. No. 60508 C.

Power Plant.

The Power Plant of the Moctezuma Copper Company at Nacozari, Sonora, Mexico. John Langton. States the conditions to be considered in determining the kind of power, and gives an illustrated description of the power house, gas house, method of making gas, quality, quantity and records of the gas engines installed. 7400 w. Trans Am Inst of Min Engrs—Oct., 1903. No. 60507 C.

Refining.

A Laboratory Study of the Stages in the Refining of Copper. H. O. Hofman, C. K. Green and R. B. Yerxa. An account of investigations, with illustrations. 5000 w. Trans. Am Inst of Min Engrs—Oct., 1903. No. 60513 C.

Review.

Copper in 1903. Approximate estimates of production with reports from the leading copper districts, explaining local conditions. 5500 w. Eng and Min Jour—Jan. 7, 1904. No. 60146.

Smelting.

Improvements in Cheap Copper Matting for British Columbia. Ronald C. Campbell-Johnston. States the conditions and suggests improvements in the smelting, and describes a furnace designed by the writer. 2000 w. Min & Sci Pr—Jan. 9, 1904. No. 60266.

The Canadian Copper Company's Plant at Copper Cliff. An illustrated description of a 1,000-ton smelter, stating the conditions to be met. 1500 w. Eng and Min Jour—Dec. 31, 1903. No. 60025.

GOLD AND SILVER.

Alaska.

The Mining Industry in Alaska. Alfred H. Brooks. Reports of production and the activity of the various districts, giving map and illustrations. 4800 w. Eng & Min Jour—Jan. 14, 1904. No. 60234.

Assaying.

Assaying and Gold Refining. Donald Clark. Information on the work connected with assaying and with special auriferous material. Ill. 3000 w. Aust Min Stand—Dec. 10, 1903. Serial. 1st part. No. 60281 B

The Assaying of Silver-Gold Bullion. H. B. Kaeding. Describes a method adopted by the writer and found to give good results. 1400 w. Min & Sci Pr—Dec. 26, 1903. No. 59996.

British Columbia.

British Columbia. S. S. Fowler. A review of the production of gold, silver, copper and lead during 1903, with general information. 2500 w. Eng & Min Jour—Jan. 7, 1904. No. 60152.

California.

California. Charles G. Yale. A review principally of the gold and silver production for 1903, with general information. 1700 w. Eng & Min Jour—Jan. 7, 1904. No. 60159.

The Cuyrmaca Mountain Mining Region of San Diego County, California. Prof. Arthur Lakes. An illustrated description of gold mining and arrastra amalgamation in Southern California. 2700 w. Mines & Min—Jan., 1904. No. 60005 C.

Colorado.

Colorado. Forbes Rickard. A review of mining conditions during 1903, showing a falling off in the output, due to labor troubles. Reports of various districts are given in detail. 3500 w. Eng & Min Jour—Jan 7, 1904. No. 60160.

Cyanidation.

Cyanidation in the United States. Chas. H. Fulton. Reviews improvements introduced during 1903 which are being tested at various mills. 3500 w. Eng & Min Jour.—Jan. 7, 1904. No. 60157.

Testing Ores for Cyanide Treatment. R. Stuart Browne. Remarks on the value of laboratory work and on the tests for cyanide treatment. 1800 w. Min & Sci Pr—Jan. 2, 1904. Serial. 1st part. No. 60168

Dredging.

Gold Dredging. F. Winter Taylor. Describes the methods used, types of dredges, &c. Ill. 2000 w. Eng & Min Jour—Jan 14, 1904. No. 60237.

Idaho.

The Mining and Industrial Development of Central Idaho. Brief reports of the various mining properties, showing progress. 1000 w. Min Rept—Dec. 24, 1903. No. 59934.

Mexico.

The Mines of Santa Eulalia, Mexico

P. B. Aiken. Brief notes on the geology, history and character of the ore in these silver mines. 1200 w. Ill. Min & Sci Pr—Dec. 19, 1903. No. 59935.

Milling.

Milling of Silver Ores at Pachuca. Henry F. Collins. Abstract from paper on "Amalgamation and Other Wet Processes for Silver Ores in Mexico," read before the Inst. of Min. and Met., London. Describes the processes of treatment employed. 3500 w. Eng & Min Jour—Dec. 31, 1903. No. 60024.

Nevada.

Ore Deposits of Tonopah, Nevada. J. E. Spurr. Taken from report of U. S. Geol. Survey. Describes the character of the silver sulphide ores and the deposits. 1600 w. Min Rept—Jan. 7, 1904. No. 60165.

Precipitation.

A Development in Electrolytic Precipitation of Gold and Silver from Cyanide Solutions. E. M. Hamilton. Describes modifications in the Siemens-Halske process which have been developed by Charles Butters & Co., Ltd., in Mexico and the United States. 7000 w. Jour Chem, Met & Min Soc of S. Africa—Nov., 1903. No. 60287 E.

Production.

Production of Gold and Silver in the United States. T. A. Rickard. Tabulated statement of production and distribution with general review. 1000 w. Eng & Min Jour—Jan. 7, 1904. No. 60144.

The Gold and Silver Production of the World. T. A. Rickard. Reports the yield of the principal regions, reviewing conditions. 1500 w. Eng & Min Jour—Jan. 7, 1904. No. 60145.

South Africa.

The Transvaal. W. Fischer Wilkinson. Reports a steady expansion during 1903, giving tables showing the production and general information. 2500 w. Eng & Min Jour—Jan. 7, 1904. No. 60153.

United States.

Mining in the Southwest. William P. Blake. A brief review of mining development in Arizona, Nevada and Southern California, restricted to the precious metals and other ordinary metals with the exception of copper. 2400 w. Eng & Min Jour Jan. 7, 1904. No. 60158.

Western Australia.

Mining in Western Australia. A G. Charleton. A report of steady progress during 1903, with important deep level developments and discoveries. 2700 w. Eng & Min Jour—Jan. 7, 1904. No. 60154.

Metallurgical Progress in Western Australia. Alfred James. Reports a reduction of 25 per cent. in treatment costs at some of the mines, giving details; the success of the combination process, and general details. 1800 w. Eng & Min Jour—Jan 7, 1904. No. 60155.

Witwatersrand.

Mine Labor and Costs on the Witwatersrand. T. Lane Carter. Shows how reduction in cost of working these gold mines has been effected, and the conditions of native and white labor. 1000 w. Eng & Min Jour—Dec. 31, 1903. No. 60023.

Observations on the Metallurgical Practice of the Witwatersrand. Discussion of paper by Harry S. Denny. 11500 w. Jour Chem, Met & Min Soc of S. Africa—Nov., 1903. No. 60286 E.

IRON AND STEEL.

Billet Mill.

The Clairton Twenty-eight Inch Three-High Steel Billet Mill. Illustrates and describes a billet mill with improved housings, hydraulic lifting tables and electrically-driven rollers. 1000 w. Eng Rec—Jan. 2, 1904. No. 60059.

Blast Furnaces.

The Platz Method of Calculating Furnace Burdens. J. B. Nau. An explanation of the method of B. Platz, based on observations extending over several years. 3300 w. Ir Age—Jan. 28, 1904. No. 60504.

Charcoal Iron.

A New Charcoal Retort Plant. Ernst A. Sjöstedt. Illustrates and describes the plant of the Algoma Steel Co., at Sault Ste. Marie, Ont. 2000 w. Ir Age—Jan. 28, 1904. No. 60505.

Converters.

Side Blow Converters. N. Lilienberg. Read before the Philadelphia Found. Assn. Discusses the advantages and disadvantages, the construction, operation, &c. 6400 w. Ir Age—Jan. 14, 1904. No. 60224.

Electric Smelting.

See Electrical Engineering, Electrochemistry.

Fuels.

By-Product Oven Gas and Tar as Fuels for the Open-Hearth Furnace. David Baker. Gives the experience at the works of the Dominion Iron & Steel Co., Sydney, Cape Breton. 1200 w. Ir & Steel Met—Jan., 1904. No. 60348 D.

Iron Industry.

See Industrial Economy.

Lake Superior.

The Lake Superior Iron Region. Report of production during the past year, with general information of exploration work, systems of mining, and related matters. 3000 w. Eng & Min Jour—Jan. 14, 1904. No. 60238.

Rails.

The Manufacture of Iron and Steel Rails in Western Pennsylvania. James M. Swank. Extracts from an article in the *Penn. Mag. of Hist. & Biog.* A review of the early history of rail manufacture. 2000 w. Ir Age—Jan. 21, 1904. No. 60309.

Steel Industry.

See Industrial Economy.

Steel Plant.

The Largest Steel Plant in the World. An illustrated detailed description of the great undertaking of the Lackawanna Steel Company, at Buffalo, N. Y. 12800 w. Ir Age—Jan. 7, 1904. No. 60048.

The New Plant of the Lackawanna Steel Company, at South Buffalo. An illustrated detailed description of this mammoth plant, noting the novel features in construction and equipment. 12300 w. Ir Trd Rev—Dec. 31, 1903. No. 59999.

See Also Mechanical Engineering, Materials.

MINING.

Accidents.

Fatal Accidents in Metal Mining in the United States. Frederick L. Hoffman. Gives information concerning the number of accidents in different years, discussing the causes so far as ascertained. 1800 w. Eng & Min Jour—Jan. 14, 1904. Serial. 1st part. No. 60235.

Alaska.

Mining Opportunities in Alaska. Jno. D. McGillivray. Information concerning the climate and conditions affecting mining and transport, the returns for 1903, and facts of interest. 1800 w. Min & Sci Pr—Jan. 9, 1904. No. 60265.

Alluvial Mining.

Deep Alluvial Mining. D. H. Browne. An illustrated article giving practical hints and descriptions of methods which have been employed in the mines of New South Wales, Australia. 3800 w. Mines & Min—Jan., 1904. No. 60006 C.

Appliances.

Improved Mining Appliances in Belgian Collieries. A Marcette, in *Annales des Mines de Belgique*. An illustrated article considering method of deepening a pit from below, movable stage for lining a shaft, mono-rail haulage, &c. 1800 w. Col Guard—Dec. 24, 1903. No. 60119 A.

Australia.

The Eastern States of Australia. F. Danvers Power. A report of the output from Queensland, New South Wales, South Australia, and Tasmania, with information of conditions during 1903. 3300 w. Eng & Min Jour—Jan. 7, 1904. No. 60156.

Development.

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W. H. Storm
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Pr—Dec. 26,
59995.

Electric Power

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Explosion.

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Explosives.

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Mining in
A review of
last year. 32
7, 1904. No.

Mine Power.

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schr f Berg u Hüttenwesen—Jan. 9, 1904. No. 60465 D.

Mining.

The Mining of Non-Metallic Minerals. Bennett H. Brough. The first of a series of lectures. The present number deals with combustible minerals, the coals and bitumens. Ill. 6400 w. Jour Soc. of Arts —Dec. 25, 1903. Serial. 1st part. No. 60040 A.

Montana.

Montana. William A. Akers. A review of the mining industry during 1903. 2000 w. Eng & Min Jour—Jan. 7, 1904. No. 60161.

New Territory.

The Outlook for Mining in the New Territory Opened Up by the San Pedro, Los Angeles & Salt Lake Railroad. M. S. Duffield. A report of information gained during an eight months' trip through the proposed route. 2000 w. Eng & Min Jour—Jan 21, 1904. Serial. 1st part. No. 60363.

Ontario.

Ontario. Thomas W. Gibson. A review of the progress of the mining industry during 1903. 1800 w. Eng & Min Jour—Jan. 7, 1904. No. 60151.

Ore Deposits.

The Brown Iron Ore Deposits of the Kisel District in the Ural (Ueber die Brauneisensteinlagerstätten des Bergrevieres von Kisel im Ural). L. Mrazec and L. Duparc. A geological account of important iron ore deposits in the vicinity of Soltkamsk, in the Government of Perm, Russia. Two articles. 4500 w. Oesterr Zeitschr f Berg u Hüttenwesen—Dec. 19, 26, 1903. No. 60462 each D.

Theories of Ore Deposition Historically Considered. S. F. Emmons. Presidential address before the Geological Society of America. A review of the theories advanced to explain the occurrence and origin of ores. 3000 w. Eng & Min Jour—Jan. 21, 1904. No. 60365.

Production.

Metal and Mineral Production of the United States in 1903. Tabulated estimates and statistics of the year's production. 2500 w. Eng & Min Jour—Jan. 7, 1904. No. 60143.

Safety.

Safety Devices for Inclined Planes (Appareils de Sécurité pour Plans Inclinés). H. Schmerber. Describing various forms of locks, brakes and automatic safety catches used in the mines of Austria. Two articles. 3500 w. Génie Civil—Dec. 26, 1903: Jan. 2. 1904. No. 60403 each D.

Sand Removal.

Methods of Removing Sand at the Wilczek Mines in Polnisch-Ostrau (Mitteilungen aus der Praxis des Schlammversatzverfahrens auf dem Gräflich Wilczekschen Dreifaltigkeitschachte in Polnisch-Ostrau). J. Mauerhofer. Describing the method of removing the sand without choking the pipes. 2000 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—Jan. 2, 1904. No. 60464 D.

Shaft Fittings.

Iron Shaft Fittings with Cage Guides on One Side. F. Schulte in *Glückauf.* Illustrated description of fittings in use in several pits in the Dortmund district. 800 w. Col Guard—Jan. 15, 1904. No. 60394 A.

Shaft Sinking.

The Deepening of the Shafts of the Wintershall Mine, near Heringen (Das Abteufen des Schachtes der Gewerkschaft Wintershall bei Heringen an der Werra). H. Klose. Describing the use of the Tomson hoisting method for deepening shafts through water-bearing strata. 2000 w. Glückauf—Jan. 9, 1904. No. 60468 D.

Sulphides.

The Delprat or Salt-Cake Process for Mixed Sulphides. Donald Clark. Explains several processes for the recovery of sulphides from their ores. 800 w. Eng & Min Jour—Jan. 21, 1904. No. 60366.

Tombstone.

Tombstone and Its Mines. William P. Blake. Notes on recent developments in the Tombstone District, Arizona. 900 w. Trans Am Inst of Min Engrs—Oct., 1903. No. 60511.

Transport.

Underground Handling and Transport of Ore. Charles B. Saner and George Carter. Considers the conveying of the broken ore to levels, and transport of ore to shaft-loading stations. Chiefly in reference to the Rand. 5000 w. Jour Chem, Met & Min Soc of S. Africa—Nov., 1903. No. 60285 E.

Utah.

Utah. Jas. W. Neill. An account of the mining progress during 1903, with reports of various camps. Ill. 2200 w. Eng & Min Jour—Jan. 7, 1904. No. 60162.

Valuation.

The Valuation of a Well-Developed Mine. A. W. Warwick. Discusses methods and gives formulæ for calculating values. 2800 w. Min Rept—Dec. 31, 1903. No. 59986.

Water-Hoisting.

Water-Hoisting in the Pennsylvania Anthracite Region. R. V. Norris. A discussion of this paper at Albany meeting. 1200 w. Trans. Am Inst of Min Engrs—Feb., 1903. No. 60509.

MISCELLANY.

Asphalt.

The Asphalt Deposits of San Valentino in Italy (Die Asphalt grauben von San Valentino in Italien). An account of the working of these important deposits in the Abruzzi, Italy. 1500 w. Oesterr Zeitschr f Berg u Hüttenwesen—Dec. 26, 1903. No. 60463 D.

Bitumen.

Bitumen and Oil Rocks. G. C. Broadhead. Gives theories regarding oil formation, and considers prospecting, oil zones, and some of the remarkable districts. 3000 w. Am Geol—Jan., 1904. No. 60076 D.

Lead.

Lead in 1903. W. R. Ingalls. The production in the United States is reported by districts, with brief reviews of the lead markets of New York and London. 5000 w. Eng & Min Jour—Jan. 7, 1904. No. 60147.

Tin.

Losses in Vanning Tin Ores. Richard Pearce. Describes experiments made with a view to determining approximately the accuracy of the ordinary process of vanning. 900 w. Eng & Min Jour—Jan. 21, 1904. No. 60364.

Tin in 1903. Mainly a review of the New York and London markets. 2500 w. Eng & Min Jour—Jan. 7, 1904. No. 60149.

Tin in the York Region, Alaska. Arthur J. Collier. Gives results of a trip made to investigate the resources of this region. One tin ledge was found and other minerals of value. Ill. 1500 w. Eng & Min Jour—Dec. 31, 1903. No. 60021.

Zinc.

Progress of the Zinc Industry in Missouri During 1903. Frank Nicholson. Report of the production, comparing with previous years, and discussing features of the industry. 1500 w. Eng & Min Jour—Jan. 14. 1004. No. 60236.

Zinc in 1903. W. R. Ingalls. A report of the zinc business in the United States for the year, with review of the New York and London markets. 6000 w. Eng & Min Jour—Jan. 7, 1904. No. 60148.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION

Express Trains.

The Origin of British Express Trains. W. B. Paley. A brief review of this feature of British railroading. 1500 w. R R Gaz—Jan. 8, 1904. No. 60194.

Foreign Practice.

Impressions of Foreign Railroad Practice. The first of a series of articles giving an interesting discussion of transportation methods. The present article considers English operation. 2700 w. Am Engr & R R Jour—Jan., 1904. Serial. 1st part. No. 60104 C.

Train Services.

British and French Train Services in 1903. Charles Rous-Marten. A review of the general character and tendency of the principal train services of Great Britain and France. 4000 w. Engr, Lond—Jan. 8, 1904. No. 60302 A.

MOTIVE POWER AND EQUIPMENT.

Air-Brakes.

How Air-Brake Tests Are Made. An illustrated article describing how modern brake trials are made and data secured. 6000 w. Loc Engng—Jan., 1904. No. 60094 C.

Car Heating.

Car Heating by Steam Mixed with Air; Eastern Railway of France. Translated from *Revue Generale des Chemins de Fer.* Illustrated description of system in use. 800 w. Eng News—Dec. 31, 1903. No. 60028.

The Heating System of the Eastern Railway of France (Chauffage des Trains du Réseau de l'Este). H. Guérin. An account of the practical operation of the Lancrenon system, using a combination of steam and compressed air. 2000 w. 1 plate. Génie Civil—Jan. 2, 1904. No. 60406 D.

Cars.

50-Ton Steel Underframe Box Car. Illustrated description of cars intended for grain traffic, built for the Illinois River Packet Co. 600 w. R R Gaz—Jan. 1, 1904. No. 60071.

Special Saloon for Royal Train, London and North-Western Railway. Illustrated detailed description. 900 w. Engng—Jan. 15, 1904. No. 60502 A.

The Development of Steel Freight Cars in the United States. A review of the situation, with editorial discussion. 8500 w. Eng News—Jan. 7, 1904. No. 60139.

Vestibule Stock Car. Illustrated description with statement of advantages claimed. 600 w. Loc Engng—Jan., 1904. No. 60092 C.

High Speed.

The Design of Locomotives and Motor Cars to Attain High Speeds (Die Gestaltung der Lokomotiven und Einzelfahrzenge zur Erreichung Hoher Fahrgeschwindigkeiten). Albert Frank. A discussion of the resistances to be overcome at high speeds, and the corresponding influences upon design and construction. 3000 w. Zeitschr d Ver Deutscher Ing—Jan. 9, 1904. No. 60421 D.

Locomotives.

Baldwin Four-Cylinder Balanced Compound Locomotives for the Santa Fe. Illustrated detailed description, with data of tests. 1000 w. R R Gaz—Jan. 22, 1904. No. 60375.

Chesapeake & Ohio Eight-Wheel Switching Locomotive. An illustrated description of probably the heaviest switching locomotive ever built. 500 w. Ry Age—Jan. 22, 1904. No. 60369.

Compound Engines. Editorial Review of the development and the advantages. 2500 w. Loc Engng—Jan., 1904. No. 60091 C.

Curious Express Locomotive. From *The Locomotive Magazine.* Illustrated description of a suggested design, adapted from a Continental design introduced on the Southern Italian Ry. 600 w. Loc Engng—Jan., 1904. No. 60090 C.

Heavy Consolidation Locomotive, Lake Shore & Michigan Southern Ry. Illustrated description of an engine of the 2-8-0 type. 1500 w. Ry & Engng Rev—Jan. 2, 1904. No. 60088.

Heavy Tank Locomotive for the Great Northern Railway. Two-page plate and drawings of an engine for suburban traffic, with brief description. 700 w. Engng—Dec. 25, 1903. No. 60118 A.

Locomotive Operation. G. R. Henderson. The first of a series of articles discussing the various laws of mechanics which govern a locomotive in operation. 4000 w. Ry Age—Jan. 15, 1903. Serial. 1st part. No. 60264.

Locomotives for Special Service on British Railways. J. F. Gairns. With numerous illustrations of inspection, crane, works, and other special forms of locomotives. 3000 w. Engineering Magazine—Feb., 1904. No. 60473 B.

New Express Engines, North-Eastern Railway. Illustration, with particulars of four wheel coupled engines with leading bogie and a pair of carrying wheels under the fire-box. 800 w. Engr, Lond—Jan. 15, 1904. No. 60500 A.

Position of Reverse Lever on Piston Valve Engines. Jas. Spellen. Gives the writer's ideas on the proper handling of these engines. 1200 w. Loc Engng—Jan., 1904. No. 60089 C.

Prussian State Railway Locomotives. Quotations from the specifications dealing with the quality and testing of material used in building rolling-stock. 6500 w. Engng—Jan. 8, 1904. No. 60-301 A.

Superheated Steam Freight Locomotives—Saxony State Railways. Charles R. King. Illustrated description of a recent design for heavy grades. 2000 w. R R Gaz—Jan. 8, 1901. No. 60195.

The Development of the Eight-Wheel Connected Engine on the Baltimore & Ohio Railroad. J. Snowden Bell. An illustrated historical review. 3000 w. Loc Engng—Jan., 1904. No. 60093 C.

The Turning Moments of Four-Cylinder Balanced Compound Locomotives. Calls attention to an error in an article by Edward L. Coster in the December issue of the *American Engineer.* Ill. 1000 w. R R Gaz—Jan. 1, 1904. No. 60066.

Motor Car.

Steam Motor Car for the Taff Vale Railway. Illustration and brief description of car which has been running for some time. 400 w. Engng—Jan. 8, 1904. No. 60298 A.

Railway Lighting.

The Economy of Compressed Acetylene Gas for Lighting Railway Cars, Stations and General Railway Lighting. E. G. Fisher. An explanation of this system and its advantages, with general discussion. 6300 w. Ill. Pro Iowa Ry Club—Nov. 17, 1903. No. 59952.

NEW PROJECTS.

Alaska.

Arctic Railway Building. George E. Walsh. Map and illustrated description of roads built and under construction in Alaska and account of the benefits already apparent. 2500 w. Cassier's Mag—Jan., 1904. No. 60277 B.

Brazil.

The Railroad Around the Falls of the Madeira River, Brazil. O. F. Nichols. Historical review of earlier attempts to open this rich district, and the project now under consideration. Map. 2500 w. R R Gaz—Jan. 1, 1904. No. 60070.

China.

Railways in South China. An interesting account of some engineering experiences in the construction of the Yuen Han Ry. 2200 w. Wisconsin Engr—Dec., 1903. No. 59966 C.

Relocation.

Relocation of the Central Massachusetts Railroad Around the Wachusett Reservoir. An illustrated description of heavy construction work on the new line made necessary by the construction of this reservoir. 3000 w. Eng Rec—Jan 2, 1904. No. 60058.

Simplon Routes.

The Western Railway Connections to the Simplon Tunnel (Die Westlichen Zufahrts linien zum Simplon tunnel). H. Elskes. A comparison of existing routes, together with an examination of the possible modifications in railway systems of Switzerland and France, due to the opening of the tunnel. 2500 w. Schweiz Bauzeitung—Jan. 9, 1904. No. 60459 B.

Transcontinental.

Notes on Early Canadian Trans-Continental Railway Projects. Briefly reviews projects dating back nearly fifty years. 1800 w. Eng News—Jan. 21, 1904. No. 60317.

PERMANENT WAY AND BUILDINGS.

Rail Bonds.

Rail Bonds. W. E. Harrington. Calls attention to interesting features, bonds and methods employed recently, testing, and conclusions based on experience. Ill. 2000 w. Jour Fr Inst—Jan., 1904. No. 60335 D.

Shops.

Seaboard Air Line Shops at Portsmouth, Va. Illustrated detailed description of buildings built to replace those destroyed by fire. 1200 w. Ry Age—Jan. 15, 1904. No. 60263.

Signals.

A New Interlocking Machine; the Pneumatic Signal Co.'s All-Electric Machine. An illustrated description of a machine recently introduced. 3000 w. Eng News—Jan. 14, 1904. No. 60252.

Electric Interlocking for the Texas & Pacific Ry., at Texarkana. Illustrated description of an all-electric installation where there are many grade crossings. 3000 w. Ry & Engng Rev—Jan. 9, 1904. No. 60225.

Single Semaphore for Multiple Route Indication. An illustrated description of Annet's route indicating system. 800 w. Bul Int Ry Cong—Dec., 1903. No. 59972 E.

Snow Sheds.

Telescopic Snow Sheds on the Central Pacific. An illustrated article describing the conditions making snow sheds necessary, and the various designs that have been used, especially the recent telescopic sheds. 1200 w. R R Gaz—Jan. 22, 1904. No. 60376.

Station.

The New Bridgeport Station. Elevation, cross section, plan, and brief description of this new station on the N. Y., N. H. & H. R. R. On account of recent track elevation the train level will be at the second story. 500 w. R R Gaz—Jan. 22, 1904. No. 60374.

The New Southern Pacific Passenger Station at San Antonio, Tex. John D. Isaacs. Illustration, with brief description of a recent adaptation of the mission style of architecture. 600 w. Eng News—Dec. 31, 1903. No. 60026.

Terminals.

Design and Operation of Division and Tide-Water Terminals. C. L. Bardo. A discussion of inadequate yard facilities, and yard design, methods of switching and their efficiency, &c., successful operation of yards. General discussion follows. 1300 w. N Y R R Club—Dec. 18, 1903. No. 60330.

Wabash Terminals at St. Louis. Plans and description of arrangements at the World's Fair grounds. 1400 w. Ry Age—Jan. 22, 1904. No. 60368.

Tracks.

The Necessity for Track Improvement. Max Barschall. Discusses things affecting the strength and endurance of tracks, and the great need of improvements due to increased loads and speeds. 1000 w. R R Gaz—Jan. 1, 1904. No. 60069.

Track Plans for the Washington Union Station. Gives track plans which differ radically from the accepted standards for terminal station arrangement. 1600 w. R R Gaz—Jan. 15, 1904. No. 60255.

Tunnel Ventilation.

The Ventilation of Some Continental Tunnels. Begins an account of notable installations, showing what has been done on the Continent. 3000 w. Engr, Lond—Jan. 15, 1904. Serial. 1st part. No. 60396 A.

STREET AND ELECTRIC RAILWAYS

Alternating Currents.

Electric Traction with Alternating-Current. Editorial review of paper by A. C. Eborall. 2500 w. Engng—Jan. 1, 1904. No. 60212 A.

Belgium.

The Light Railways of Belgium (Die Belgischen Kleinbahnen). H. Pforr. A general review of the tramway and interurban railway systems of Belgium, with comparative diagrams showing the rate of growth. 3000 w. Glaser's Annalen—Jan. 1, 1904. No. 60453 D.

Brakes.

Brakes and Sand. Edward C. Boynton.

Discusses arrangements for quickly stopping a car, and the value of sand properly applied. 1200 w. St Ry Jour—Jan. 2, 1904. No. 60018 C.

The Development of Railroad Braking. R. A. Parke. Abstract of paper read before the New England St. Ry. Club. A review of the development. 4800 w. St Ry Jour—Jan. 2, 1904. No. 60020 C.

The Westinghouse Electro-Magnetic Brake. Georges Lesourd. An illustrated description with examination of the advantages claimed. 3800 w. Bul Int Ry Cong—Dec., 1903. No. 59973 E.

California.

Electrical Equipment of the North Shore Railroad from San Francisco to San Rafael. Illustrates and describes a system of electric third-rail traction having many interesting features. 4000 w. St Ry Jour—Jan. 2, 1904. Serial. 1st part. No. 60014 C.

Chamonix.

The Chamonix Electric Railway. Archibald Wilson. An illustrated description of this short but interesting line. Water power and protected third-rail current supply. 2500 w. Cassier's Mag—Jan., 1904. No. 60272 B.

Economics.

Railway Economics. Hon. Robert P. Porter. A review of the Royal Commission, appointed for the purpose of inquiring into the problems of London locomotion. 8200 w. Trac & Trans—Jan., 1904. Serial. 1st part. No. 60292 E.

Electro-Pneumatic.

Arnold Single-phase Electro-pneumatic Railway System. Illustrated detailed description of the work of Bion J. Arnold in this field. 5700 w. W Elect'n—Jan. 2, 1904. No. 59957.

The Arnold-Electro-Pneumatic Railway System, Its Application and Experiments Therewith in Connection with the Lansing, St. John & St. Louis Railway. Illustrated detailed description of the single-phase electric traction system developed by Bion J. Arnold. 4000 w. Elec Rev, N. Y—Jan. 2, 1904. No. 60012.

Insulation.

Measurements of the Insulation of Trolley Wries (Isolationsmessungen am Fahrdraht bie Strassenbahnen). H. A. Mörk. Illustrated description of methods. 500 w. Elektrotech Zeitschr—Jan. 7, 1904. No. 60440 B.

Interurban.

Electric Interurban in Western New York. Illustrated detailed description of the recently completed line between Rochester and Canandaigua. 3800 w. St Ry Jour—Jan. 16, 1904. No. 60267 C.

Indianapolis and Northwestern Traction System. An illustrated description of the line between Indianapolis and Lafayette. 3200 w. St Ry Jour—Jan. 23, 1904. No. 60357 C.

Interurban Trolley Roads in Indiana. A study of the effect of the extensive interurban system around Indianapolis upon the business of steam roads, and the prosperity of the city and its surroundings. 3000 w. R R Gaz—Jan. 8, 1904. Serial. 1st part. No. 60193.

Rochester & Eastern Rapid Ry. Illustrated description of a high-speed electric interurban operating on its own private right of way. 2500 w. St Ry Rev—Jan. 20, 1904. No. 60379 C.

The Jackson & Battle Creek Railway. W. G. Fargo. Illustrates and describes a road in Southern Michigan, built mostly on private right of way, using third-rail system. 3000 w. St Ry Jour—Jan. 2, 1904. No. 60015 C.

The Muncie, Hartford & Ft. Wayne Ry. An illustrated description of route, construction, stations, rolling stock, &c., of a line in Indiana. 4000 w. St Ry Rev—Dec. 20, 1903. No. 59938 C.

Main Lines.

The Electrification of Railways (Ist der Bisher Eingeschlagene Weg, für unsere. Verkehrsmittel höhere Geschwindigkeiten zu Erreichen, der Reichtige?). A. Hecker. A discussion of the probable development of electric traction on German railways. 2000 w. Elektrotech Rundschau—Jan. 1, 1904. No. 60452 D.

Massachusetts.

The Massachusetts Electric Companies. Outlines the scheme for substituting a high-tension alternating-system. Also gives an illustrated description of the new Quincy Point steam-turbine power house. 5000 w. St. Ry Rev—Dec. 20, 1903. No. 59940 C.

Newcastle.

Electric Traction on the North-Eastern Railway. Illustrates and describes the equipment of the Newcastle local lines. 7500 w. Tram & Ry Wld—Jan 14, 1904. No. 60519 B.

N. Y. Central R. R.

Electric Power on the New York Central. Editorial discussion of some arguments that may have led to the adoption of direct-current apparatus. 2000 w. St Ry Jour—Jan. 9, 1904. No. 60190 C.

Performance.

Determination of the Performance of Electric Tramways in America (Bestimmung der Leistung von Elektrischen Bahnmotoren in den Vereinigten Staaten von Amerika). Fr. Gutbrod. An examination of the graphical methods of plotting railway performances by curves. Two articles, 8000 w. Zeitschr d Ver Deutscher Ing—Dec. 19, 26, 1903. No. 60414 each D.

Power House.

The Power House of the Interborough Rapid Transit Company, New York. Brief illustrated description prepared on the occasion of a recent visit of the Am. Soc. of Civ. Engrs. 2000 w. Eng Rec—Jan. 23, 1904. No. 60354.

Rail Joints.

Conditions Which Affect the Resistance of a Bonded Rail Joint. Charles R. Sturdevant. Discusses the four distinct resistances which makes up the total ohmic resistance. 2000 w. St Ry Rev—Dec. 20, 1903. No. 59941 C.

Rapid Transit.

The New York Rapid Transit Railway. Sydney W. Ashe. An interesting illustrated description of the route and construction of the New York Rapid Transit railway. 5000 w. W Elect'n—Jan. 2, 1904. No. 59956.

Review.

Electric Traction in 1903. Dr. Louis Bell. A review of the year's progress. 2000 w. Elec Rev, N. Y—Jan. 9, 1904. No. 60179.

Richmond, Va.

The Street Railway Systems of Richmond, Va. Illustrates and describes improvements due to a consolidation of interests. 5000 w. St Ry Jour—Jan. 2, 1904. No. 60016 C.

Rolling Stock.

The Rolling Stock of the Great Northern and City Railway. Illustrates and describes coaches to be used in the multiple-unit system. 700 w. Engr, Lond—Dec. 25, 1903. No. 59983 A.

Seattle.

The Stone & Webster Properties on Puget Sound. An illustrated article describing the lines of the Seattle Electric Co., their equipment, management, &c., 5700 w. St Ry Rev—Jan. 20, 1904. No. 60377 C.

Single Phase.

Single-Phase Car Equipment at East Pittsburg. Illustrates the truck and car in operation on the Interworks Railway of the Westinghouse Co. 800 w. St Ry Jour—Jan. 23, 1904. No. 60358 C.

Traction with Single-Phase Alternating-Current. Speed Regulation and Recovery of Energy (Traktion mit Einphasenstrom. Regelung der Geschwindigkeit und Wiedergewinnung von Arbeit). Marius Latour. Discussion of motor types and connections. Diagrams. 800 w. Elektrotech Zeitschr—Dec. 17, 1903. No. 60429 B.

Some Possibilities of the Alternating Current Single Phase Railway Motor. A. H. Armstrong. Abstract of a paper read before the Elec. Sec. of the Canadian Soc. of Civ. Engrs. A general discussion of the operation of steam lines by the alternating current railway motor. 3300 w. Can Elec News—Jan., 1904. No. 60217.

See Electrical Engineering, Power Applications.

Southport.

Electrification of the Southport Branch of the Lancashire and Yorkshire Railway. 3000 w. Tram & Ry Wld—Jan. 14, 1904. No. 60520 B.

Electrification of the Liverpool Southport Line. Interior and exterior views of the electric train, with brief account of the electrification of the line. 800 w. Engr, Lond—Jan. 1, 1904. No. 60132 A.

Stops.

The Effect of Frequent Stops in High-Speed Railroading. A. H. Armstrong. Showing that a stop in high-speed railroading is expensive and far-reaching in its results. 2000 w. St Ry Jour—Jan. 9, 1904. No. 60191 C.

Stray Currents.

Unscientific Electric Engineering: Destruction of Underground Pipes, etc. H. W. Spang. Discusses the defects of the engineering branch of electrical science, the destruction caused, and the remedy. 2500 w. Am Gas Lgt Jour—Jan. 18, 1904. No. 60257.

See Electric Engineering, Measurement.

Surface Contact.

The G. B. Surface-Contact System. An illustrated description of the principal details of this system, a trial line having been placed in operation in England. 2200 w. Elec Engr, Lond—Jan. 8, 1904. No. 60288 A.

Switzerland.

The Wetzikon-Meilen Electric Railway (Chemin de Fer Electrique de Wetzikon-Meilen). H. Somach. Describing the interurban trolley line between Meilen on the Lake of Zurich and a number of inland towns. The overhead wire is used, and Oerlikon equipment. 2500 w. 1 plate. Génie Civil—Dec. 26, 1903. No. 60402 D.

Zossen Experiments.

The High-Speed Electric Railway Experiments between Marienfelde and Zossen (Schnellbahnversuche Marienfeldezossen). Illustrated description of the Siemens-Halske car and the track and roadbed. 700 w. Elektrotech Zeitschr—Dec. 31, 1903. No. 60438 B.

EXPLANATORY NOTE—THE ENGINEERING INDEX.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

Serial publications are indexed on the appearance of the first installment.

SPECIAL NOTICE.—To avoid the inconvenience of letter-writing and small remittances, especially from foreign countries, and to cheapen the cost of articles to those who order frequently, we sell coupons at the following prices:—20 cts. each or twelve for $2.00, thirty-three for $5, and one hundred for $15.

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CARD INDEX.—These pages are issued separately from the Magazine, printed on one side of the paper only, and in this form they meet the exact requirements of those who desire to clip the items for card-index purposes. Thus printed they are supplied to regular subscribers of THE ENGINEERING MAGAZINE at 10 cts. per month, or $1.00 a year; to non-subscribers, 25 cts. per month, or $3.00 a year.

THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* Boston.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Jl. of Science. *m.* New Haven, U.S.A.
American Machinist. *w.* New York.
American Shipbuilder. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. d Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *qr.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Sydney.
Autocar. *w.* Coventry, England.
Automobile. *m.* New York.
Automobile Magazine. *m.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Brick Builder. *m.* Boston.
British Architect. *w.* London.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bulletin American Iron and Steel Asso. *w.* Philadelphia, U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. Soc. Int. d Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Montreal.
Canadian Mining Review. *m.* Ottawa.
Cassier's Magazine. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Electrical Engineer. *w.* London.
Electrical Review. *w.* London.

Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Electrochemical Industry. *m.* New York.
Electrochemist and Metallurgist. *w.* London.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Chicago.
Engineering. *w.* London.
Enginering and Mining Journal. *w.* New York.
Enginering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penna. *m.* Pittsburg, U.S.A.

Fire and Water. *w.* New York.
Foundry. *m.* Cleveland, U. S. A.

Gas Engineers' Mag. *m.* Birmingham.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e. d. Str. Ferr. *w.* Rome.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.

Ice and Refrigeration. *m.* New York.
Ill. Zeitschr. f. Klein u. Strassenbahnen. *s-m.* Berlin.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron and Steel Metallurgist. *m.* Boston.
Iron and Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.

Jour. Am. Foundrymen's Assoc. *m.* New York.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Journal of Sanitary Institute. *qr.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery *b-m.* Fort Monroe, U.S.A.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U.S.A.

Locomotive. *m.* Hartford, U. S. A.
Locomotive Engineering. *m.* New York.

Machinery. *m.* New York.
Madrid Cientifico. *t-m.* Madrid.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Metal Worker. *w.* New York.
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* City of Mexico.
Minerva. *w.* Rome.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci Press. *w.* San Francisco.
Mining Reporter. *w.* Denver, U. S. A.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Modern Machinery. *m.* Chicago.
Mouvement Maritime. *w.* Brussels.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *m.* New York.

Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Nineteenth Century. *m.* London.
North American Review. *m.* New York.

Oest. Wochenschr. f. d. Oeff Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg- & Hüttenwesen. *w.* Vienna.
Ores and Metals. *w.* Denver, U. S. A.

Pacific Coast Miner. *w.* San Francisco.
Page's Magazine. *m.* London.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Procedings Engineers' Club. *qr.* Philadelphia.
Pro. St. Louis R'Way Club. *m.* St. Louis, U. S. A.
Progressive Age. *s-m.* New York.

Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.

Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago
Review of Reviews. *m.* London & New York.
Revista d Obras. Pub. *w.* Madrid.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Gen. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.

Schiffbau. *s-m.* Berlin.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Engng. *m.* Ithaca, N. Y.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens' Institute Indicator. *qr.* Hoboken U.S.A.
Stone. *m.* New York.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago.

Tijds. v h Kljk. Inst. v Ing. *qr.* Hague.
Traction and Transmission. *m.* London.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining. Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.

Wiener Bauindustrie Zeitung. *w.* Vienna.
World's Work. *m.* New York.

Yacht. *w.* Paris.

Zeitschr. d. Mitteleurop. Motorwagen Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a S.
Zeitschr. f. Electrotechnik. *w.* Vienna.

CURRENT RECORD OF NEW BOOKS

Note—Our readers may order through us any book here mentioned, remitting the publisher's price as given in each notice. Checks, Drafts, and Post Office Orders, home and foreign, should be made payable to THE ENGINEERING MAGAZINE.

Boilers.

Steam Boilers, Their Theory and Design. By H. de B. Parsons, B. S., M. E. Size, 9 by 6 in.; pp. xii, 375; figures, 185. Price, $4. New York, London and Bombay: Longmans, Green, and Co.

Although there have been many books on steam boilers, the subject possesses perennial interest, and with the advance in methods of steam generation there must be a corresponding growth of its literature. The present work is founded on a series of lectures delivered to students at the Rensselaer Polytechnic Institute, where the author is professor of steam engineering, and it therefore necessarily is laid down on text-book lines, but it is more than a text-book, and will be found of service to the designing engineer and of great interest to all who wish to keep abreast of the modern developments in steam engineering. Many of the principal types of boilers, both fire-tube and water-tube, in use at the present day, are illustrated and described, and their respective advantages and defects set forth. One chapter contains accounts of the various kinds of solid, liquid and gaseous fuels, particular attention being given to fuel oil and the methods of burning it. Other sections of the book are devoted to materials of construction, boiler details and fittings, mechanical stokers, artificial draft, incrustation, corrosion, chimney design, smoke prevention, testing, and many more topics. Throughout the book there is much information concerning the latest standard rules and specifications, and many tables are given. An appendix contains descriptions of several styles of superheaters, and an index completes a very readable volume giving a comprehensive survey of modern boiler practice.

Commercial Register.

Hendricks' Commercial Register of the United States for Buyers and Sellers. Thirteenth Annual Edition. Size, 10 by 8 in.; pp. 1,226. Price, $6. New York: S. E. Hendricks Company.

With the growth of manufacturing and the increasing area of commercial transactions, it becomes more and more difficult for people with things to sell to locate all their possible customers and for buyers to know all their advantageous markets, so that a work like the present volume, which brings buyers and sellers into touch with each other, possesses a far-reaching interest and value. This book gives the names and addresses of the manufacturers and producers of practically everything that is made and produced in the United States. It also gives a list of the individuals and the firms engaged in the professions and trades connected with engineering in all its branches, architecture, construction, railroading, mining, plumbing, and similar lines of work. All the products, manufactures, trades and professions are arranged alphabetically, and when any section is large, it is sub-classified by States and by cities, with the names in each sub-division in alphabetical order. In the preparation of mailing lists covering any line of work, this book is invaluable, and it will prove of the greatest use to advertising men, manufacturers and business men, and, in fact, to everybody who has anything to buy or sell.

Engine Tests.

Engine Tests and Boiler Efficiencies. By J. Buchetti. Translated and Edited from the Third French Edition by Alexander Russell. Size, 8½ by 5½ in.; pp. xv, 255; figures, 179. Price, $3 (12s. 6d.). New York: Norman W. Henley & Co. London: Archibald Constable & Co.

It will be of interest to English-speaking engineers to compare the best Continental practice in engine and boiler testing with that in use in their own countries, and an excellent opportunity for making such a comparison is afforded by the present translation of M. Buchetti's standard work, "Guide pour l'Essai des Moteurs." In this book, the indicator receives especially full treatment, a great many forms of the instrument being illustrated and described, from the one designed by Watt to the latest external-spring, continuous-record, and optical indicators. The theory of indicators and the study of indicator diagrams have considerable attention given to them, as has also the subject of brake horse power, under which topic many styles of testing brakes are described. There is a chapter on the taking of indicator diagrams of oil and gas engines, and a note on steam-turbine testing. Other sections are devoted to the properties of steam, evaporation and a discussion of fuels, combustion, steam trials, and other subjects; and an appendix contains tables of the properties of steam, and other useful information and data.

Metric System.

The Metric Fallacy. By Frederick A. Halsey. The Metric Failure in the Textile Industry. By Samuel S. Dale. Size, 9 by 6 in.; pp. 231. Price, $1. New York: D. Van Nostrand Company.

We have here two separate treatises in one volume, both, however, bearing upon the same question: the present status of the metric system of weights and measures, especially the matter of measure of length. The first portion, that by Mr. Halsey, is the outgrowth of his paper presented before the American Society of Mechanical Engineers in December, 1902; while the second portion, due to Mr. Dale, is a critical analysis of the metric system with especial reference to the textile industry. The book is really the outcome of the effort of the Committee on Coinage, Weights, and Measures of the House of Representatives to secure the passage by Congress of a bill to make compulsory the use of the metric system in the various departments of the United States Government, with the exception of the completion of the survey of the public lands, Mr. Halsey having felt that unless some active demonstration were made against such action the bill might become law in default of any expression of adverse opinion on the part of the engineering profession. In this respect the book, with its preceding paper, has undoubtedly been a success. The testimony before the committee, which before Mr. Halsey's efforts had been largely in favor of the passage of the bill, has since that time been of a nature which has led the members of the committee to realize that some serious problems are certain to be created should it become law. Mr. Halsey shows the limited extent to which the metric system has obtained a practical working status in many countries usually counted in the metric ranks; while Mr. Dale gives a review of the extent to which old measures have persisted in the textile industries, even in France and Germany. Both portions of the work contain a mass of information concerning the facts in the case, most surprising to all who have given the question but passing attention, and of undoubted weight in connection with the consideration of the subject as a matter for legislation. Many things, which by repeated statement have come to be accepted as true about the general use of the metric system in countries in which it has been legalized, are shown to be altogether incorrect or overstated, and in the light of the investigation here made public many points in the older arguments need modification. The book should be in the hands of every one interested in the subject, and it cannot fail to have an important influence upon future attempts at compulsory legislation.

Reinforced Concrete.

Experimental Researches on Reinforced Concrete. By Armand Considère. Translated and Arranged by Leon S. Moisseiff, C. E. Size, 9 by 6 in.; pp. ix, 188; figures, 20. Price, $2. New York: McGraw Publishing Co.

Concrete-steel, or concrete strengthened by iron and steel, in various shapes, imbedded in it, has been extensively employed as a structural material in the past few years, and is finding new uses every day. The reinforcing material is applied in many ways, each "system" claiming special advantages, but most of the work hitherto has been of an empirical nature, and the scientific co-ordination of the whole subject had made but little progress before M. Considère began his investigations. His researches covered various forms of reinforced concrete, on which he made many experiments, and he afterwards worked out his theory of this material from his experimental determinations. The value of such a systematic investigation is shown not only by his theoretical results, but also by his discovery of the great advantages of hoops of metal in strengthening concrete columns and other members subjected to compressive stresses. M. Considère's researches began in 1898, and were communicated from time to time to the French Academy of Sciences, to the International Association for Testing Materials and to the *Génie Civil*. His papers have been translated into English by M. Moisseiff, and some of them published in the *Engineering Record*. They are now compiled in book form, and are arranged and classified so as to make a systematic treatise. The chapters follow, in general, the several papers in their chronological order, and are entitled: Reinforced Concrete in Bending; Deformation and Testing of Reinforced Concrete Beams; Effects of Changes in Volume of Concrete; Tensile and Compressive Resistance of Reinforced Concrete; Resistance of Concrete to Shearing and Sliding; Effect of Cracks on Stresses and Deformations; Compressive Resistance of Reinforced and Hooped Concrete. This work, embodying the results of practically the first systematic study of a material of such wide application by one of the world's foremost experimenters, is necessarily of the highest importance to all engineers and architects engaged in construction.

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NEWS SUPPLEMENT

The Engineering Magazine—October, 1903

Coming Society Meetings.

American Gas Light Association. Sec.: A. E. Forstall, 58 William St., New York. Annual convention, Oct. 21-23, at Detroit.

American Institute of Architects. Sec.: Glenn Brown, Washington, D. C. Annual convention, Oct. 15-17, at Cleveland.

American Institute of Electrical Engineers. Sec.: Ralph W. Pope, 95 Liberty St., New York. Regular meeting on fourth Friday of each month, except June, July and August, 12 W. 31st St., New York.

American Institute of Mining Engineers. Sec.: R. W. Raymond, 99 John St., New York. Next meeting, October 13, at New York.

American Railway Association. Sec.: W. F. Allen, 24 Park Place, New York. Next meeting, Oct. 28, at Richmond, Va.

American Railway Engineering and Maintenance of Way Association. Sec.: L. C. Fritch, Monadnock Block, Chicago. Annual meeting, March 15-17, 1904, at Chicago.

American Society of Civil Engineers. Sec.: C. W. Hunt, 220 W. 57th St., New York. Regular meetings, first and third Wednesdays of each month, except July and August.

American Society of Mechanical Engineers. Sec.: Prof. F. R. Hutton, 12 W. 31st St., New York. Annual meeting, Dec. 1-4, at New York.

American Society of Municipal Improvements. Sec.: Geo. W. Tillson, Municipal Building, Brooklyn, N. Y. Annual meeting, Oct. 20-22, Indianapolis.

Association of Railway Superintendents of Bridges and Buildings. Sec.: S. F. Paterson, Concord, N. H. Annual convention, Oct. 20, Quebec.

Boston Society of Civil Engineers. Sec.: S. E. Tinkham, 715 Tremont Temple. Regular meetings on third Wednesday of each month, except July and August.

Canadian Railway Club. Sec.: W. H. Rosevear, Jr., Montreal. Regular meetings on first Tuesday of each month, except June, July and August.

Canadian Society of Civil Engineers. Sec.: Prof. C. H. McLeod, 877 Dorchester St., Montreal. Regular meetings every alternate Thursday from October to May, inclusive.

Central Railway Club. Sec.: Harry D. Vought, 62 Liberty St., New York. Regular meetings on second Fridays of Jan., March, May, Sept. and Nov., Hotel Iroquois, Buffalo.

Chicago Electrical Association. Sec.: W. J. Warder, Jr., 900 Warren Ave. Regular meetings on first Friday of each month, from October to May.

Civil Engineers' Club of Cleveland. Sec.: Arthur A. Skeels, 689 The Arcade. Regular meetings on second and fourth Tuesdays of each month.

Civil Engineers' Society of St. Paul. Sec.: G. S. Edmondstone. Regular meetings on second Monday of each month.

Engineering Association of the South. Sec.: Robt. L. Lund, 2102 Hayes St., Nashville, Tenn. Regular meetings on second Thursday of each month at the Berry Block.

Engineers' Club of Chicago. Sec.: B. W. Thurtell, 1223 New York Life Building. Regular meetings on first and third Tuesdays of each month.

Engineers' Club of Cincinnati. Sec.: J. F. Wilson, P. O. Box 333. Regular meeting on third Saturday of each month, except July and August.

Engineers' Club of Columbus (Ohio). Sec.: H. M. Gates, 12½ North High St. Regular meetings on third Saturday of each month, except July and August.

Engineers' Club of Minneapolis. Sec.: Jas. B. Gilman, American Bridge Co. Regular meetings on third Monday of each month.

Engineers' Club of Philadelphia. Sec.: J. O. Clarke, 1122 Girard Street. Regular meetings on first and third Saturdays of each month, except July and Aug.

Engineers' Club of St. Louis. Sec.: H. J. Pfeifer, 920 Rialto Bldg. Regular meetings on first and third Wednesdays of each month.

Engineers' Society of Western New York. Sec.: L. W. Eighmy, 13 City Hall, Buffalo. Regular meetings, first Tuesday of each month, except July and August.

Engineers' Society of Western Pennsylvania. Sec.: Chas. W. Ridinger, 410 Penn. Ave., Pittsburg. Regular meetings on third Tuesday of each month.

Franklin Institute. Sec.: Dr. Wm. H. Wahl, 15 South 7th St., Philadelphia. General meetings on third Wednesday of each month, except July and August. Regular monthly meetings of the various sections on other days.

Iowa Railway Club. Sec.: P. B. Vermillion, Des Moines, Iowa. Regular meetings on third Tuesday of each month.

League of American Municipalities Sec.: John MacVicar, Des Moines, Iowa. Seventh annual convention, Oct. 7-9, at Baltimore.

LOUISIANA ENGINEERING SOCIETY. Sec.: G. W. Lawes, 806 Gravier St., New Orleans. Regular meetings on second Monday of each month.

MONTANA SOCIETY OF ENGINEERS. Sec.: Clinton H. Moore, Butte, Mont. Regular meetings on second Saturday in each month.

NEW ENGLAND RAILROAD CLUB. Sec.: Edw. L. Janes, Back Bay P. O., Boston. Regular meetings, second Tuesday in each month, except June, July, August and September, at Pierce Hall, Copley Square.

NEW YORK ELECTRICAL SOCIETY. Sec.: Geo. H. Guy, 114 Liberty St., New York. Meetings monthly, on different Wednesdays.

NEW YORK RAILROAD CLUB. Sec.: F. M. Whyte, Grand Central Station, N. Y. City. Regular meetings on third Friday of each month, except June, July, and August, at Carnegie Hall, 154 W. 57th St., New York.

NORTH-WEST RAILWAY CLUB. Sec.: T. W. Flannagan, Minneapolis, Minn. Regular meetings on first Tuesday after second Monday of each month, except June, July and August, alternating between Minneapolis and St. Paul.

PACIFIC COAST RAILWAY CLUB. Sec.: C. C. Borton, West Oakland, Cal. Regular meetings on third Saturday of each month at different cities.

PACIFIC NORTHWEST SOCIETY OF ENGINEERS. Sec.: G. F. Cotterill, Seattle, Wash. Meetings. monthly in Chamber of Commerce rooms, Seattle.

RAILWAY CLUB OF PITTSBURG. Sec.: J. D. Conway, P. & L. E. R. R., Pittsburg, Pa. Regular meetings on fourth Friday of each month, except June, July and August, at Hotel Henry.

RAILWAY SIGNALING CLUB. Sec.: B. B. Adams, 83 Fulton St., New York. Regular meetings on second Tuesday of January, March, May, Sept. and Nov. Annual meeting, Nov. 10, at Detroit.

RICHMOND RAILROAD CLUB. Sec.: F. O. Robinson, 8th & Main Sts., Richmond, Va. Regular meetings on second Thursday of each month, except June, July and August.

ROADMASTERS' AND MAINTENANCE OF WAY ASSOCIATION. Sec.: Chas. McEniry, Cedar Rapids, Iowa. Annual meeting, Oct. 13, 14 and 15, at Kansas City, Mo.

ROCKY MOUNTAIN RAILWAY CLUB. Sec.: J. E. Buell, 906 20th Ave., Denver. Regular meetings on first Saturday after the 15th of each month.

ST. LOUIS RAILWAY CLUB. Sec.: E. A. Chenery, Union Station, St. Louis. Regular meetings on second Friday of each month, except July and August.

SOCIETY OF CHEMICAL INDUSTRY, NEW YORK SECTION. Sec.: H. Schweitzer, 40 Stone St. Meetings on third Friday after the first Monday of each month, at Chemists' Club, 108 W. 55th St.

SOUTHERN AND SOUTHWESTERN RAILWAY CLUB. Sec.: W. A. Love, Atlanta, Ga. Regular meetings on third Thursday of Jan., April, Aug. and Nov., at Atlanta.

TECHNICAL SOCIETY OF THE PACIFIC COAST. Sec.: Otto von Geldern, 31 Post St., San Francisco. Regular meetings on first Friday of each month.

TEXAS RAILWAY CLUB. Sec.: T. H. Osborne, Pine Bluff, Ark. Regular meetings on third Monday of April and September.

WESTERN RAILWAY CLUB. Sec.: Jos. W. Taylor, 667 Rookery, Chicago. Meetings on third Tuesday of each month, except June, July and August, Auditorium Hotel, Chicago.

WESTERN SOCIETY OF ENGINEERS. Sec.: J. H. Warder, Monadnock Block, Chicago. Regular meetings on first Wednesday and extra meetings on third Wednesday of each month, except July and August.

Industrial Notes.

—The New York offices of the sales organization of the Westinghouse Electric & Manufacturing Company, consisting of the New York Sales Department, Department "I," the Export Department, and the general agent's office, have been removed to the new Hanover Bank Building, corner of Nassau and Pine Streets. The new offices occupy the entire seventeenth floor of this building, one of the finest and best equipped office buildings in the country, where the arrangements and facilities will be of the best, both for the representatives of the Company, and the public with whom they do business. The mail address of the several departments of the sales organization in New York will be No. 11 Pine Street. The telephone number, 6131 Cortlandt, remains unchanged. The executive, financial and stock transfer offices will remain on the fourth floor of the Equitable Building. The present organization of the Westinghouse Electric & Manufacturing Company has been quartered in the Equitable Building since 1889, but the rapid and material increase of business has made the above move necessary.

—The coal-handling machinery installed by the C. W. Hunt Company, of West New Brighton, N. Y., at the Lincoln Wharf power station of the Boston Elevated Railroad Company, recently lowered the world's record for rapid unloading. The coal was raised 90 feet above tide water and delivered to the storage pockets at the rate of 320 tons per hour. The installation follows in general design the standard Hunt steeple-tower rig, the moving gear and coal cracker being electrically driven, and the hoisting engine direct connected. The overhang of the folding boom is 40 feet, and the capacity of shovel 2 tons.

—The Haeseler pneumatic hammers, which the Ingersoll-Sergeant Drill Company is manufacturing, are meeting with general approval by those who have tested these tools. The "Axial Valve" mechanism used in the construction of the Haeseler hammers has produced a steady-working and unbreakable valve, thus eliminating the troubles common to pneumatic hammers in which the valve is of the straight-line reciprocating type.

—The Steamboiler Equipment Company of New York, of 20 W. Houston Street, New York, report the successful operation and acceptance of the "hydro-carbon" system as applied to the two new boilers lately erected in the United States Arsenal, at Frankford, Pa., in compliance with specifications calling for smokeless furnaces. They have also installed their system at the power house of the Bridgeton Traction Co., Bridgeton, N. J., at a plant of the Stanley Electric Mfg. Co., Pittsfield, Mass., and at the Rumford Chemical Works, Providence, R. I.

—The Heisler Mfg. Co. has let a contract to Wm. B. Scaife & Sons Co., Pittsburg, Pa., for a structural-steel machine-shop building, covering a total floor space of 25,560 square feet, to be erected immediately at St. Mary's, Ohio, for the manufacture of air compressors and pumping machinery. The selling and engineering office of the Heisler Mfg. Co. is located in the Westinghouse Building, Pittsburg, Pa.

—The Reeves Engine Co. expects, shortly, to more than double their manufacturing capacity. Among the numerous recent sales of the Reeves vertical cross-compound steam engines are two large direct-connected sets to the Providence Steel Casting Company, of Providence, R. I.

—The firm of Arthur Koppel has been awarded the contract for the building and equipping of a narrow-gauge railroad about 400 miles long by the Otavi Mining and Railroad Company. The railroad is to be used in the service of the copper mines in the district Otavi and Tsumeb in southwestern Africa. The total cost of building the road is approximately $4,500,000. The firm of Arthur Koppel has entered into relations with several of the large German banks to build this road, which has to be finished within two and one-half years. Arthur Koppel builds and equips the road complete, including rails, steel ties, rolling stock and all the other equipment. By one of the last steamers fifteen engineers of the firm left Hamburg for southwestern Africa in order to begin work.

—The National Fire Proofing Company has issued a catalogue, which, in appearance, size and character of contents, is like the standard engineering pocket-books. This volume consists chiefly of a selection of completed pages of an extensive work on fire-proof construction and materials, which will be published later and whose object, aside from serving as a more complete catalogue than the present book of the products of the National Fire Proofing Company, is to give the architect, the engineer, the builder, the insurance underwriter and all others interested reliable information concerning the fire-proofing of buildings by means of the various materials and methods in common use to-day, but more particularly by the use of the material known as porous terra cotta, the special product of most of the works of this company. The author of this treatise is Mr. Henry L. Hinton, the engineer of the company, and in the present hand-book, one of the chief features is an account of his new system of floor-arch construction, which he has called the "serrated arch." On account of the elaborate style in which this pocket-book has been issued, its price has been fixed at $3.

—The instruction of the American School of Correspondence is under the direction of members of the faculty of Armour Institute of Technology, and Dr. Gunsaulus, president of that institute, has given the work his enthusiastic support and personal supervision. Due credit will be given for the work covered by correspondence should the student later pursue his studies at the Institute. The instruction papers are prepared especially for home study, and are used as text-books by the Government in the School of Submarine Defense at Fort Totten, N. Y., and by the Westinghouse Electric and Manufacturing Company, of Pittsburg, which is using over seven hundred of the papers in the "Shop School" maintained for its employees. The paper on "Storage Batteries" is used as a text-book for the senior class in electrical engineering at Columbia University. The American School of Correspondence has students within a few miles of the Arctic circle, in the Fiji Islands and in the Falkland Islands, off of Cape Horn. It has over three hundred students in New Zealand alone. Wherever knowledge of American enterprise has penetrated, there will be found correspondence school students.

—The plant of the American Roller Bearing Company, at 32-40 Binford Street, Boston, was totally destroyed by fire on Tuesday, Aug. 18, and the machinery and stock were entirely lost. Fortunately, however, this company had been making arrangements to get into a plant outside of Boston, and had already placed orders for new machinery which would enable them to double their capacity. They are now taking immediate steps towards getting this new plant into running shape and will, therefore, not be seriously delayed in accommodating their customers. With an entirely new and enlarged equipment, the American Roller Bearing Company should be in a better position than ever to handle a large business for the coming year.

—The St. Louis Portland Cement Co. entertained the members and friends of the St. Louis Railway Club recently. A special train was furnished by the Burlington Railway, which conveyed the party first to the extensive quarries of the Cement Company, where the Burlington bridge crosses the Missouri River, and then to the cement plant at Prospect Hill, in the extreme northern portion of St. Louis. After the works, which have been in operation since January 1, 1903, had been thoroughly inspected, refreshments were partaken of, and the party then returned to town again by the Burlington Route, whose service was complimentary.

—The affairs of the Chicago Pneumatic Tool Company are in a most flourishing condition, and the prospects are exceedingly bright for them to continue so in the future. The various plants are working increased forces in order to adequately fulfill the requirements. Their foreign offices report a correspondingly cheerful outlook. The business for the month of August exceeded that transacted in August, 1902, and there is every indication that the sales of pneumatic appliances for the month of September will be very satisfactory.

—One of the prime requisites for the successful business of to-day is to make quick deliveries, and the "when" is often considered of more importance than the "how much." To further facilitate the prompt filling of orders, the Sawyer-Man Electric Company have recently established a distribution depot at the Central Stores of the Terminal Warehouse, in West 28th Street, New York. Here are kept over a million lamps in stock, so that any and all calls may be speedily and completely answered. A similar depot is situated at 30th and Market Streets, Philadelphia, and others are located in Boston, Buffalo, Syracuse, Pittsburg, Charlotte, Chicago, Denver, St. Louis, Atlanta, New Orleans, San Francisco, Seattle, and other centers of trade.

—The industrial department recently established by the Erie Railroad Company has for its purpose the further development of the territory traversed by the railroad. The company seeks to increase the number of manufacturing plants on its system and to develop the natural resources and the commerce of its territory, so that the prosperity and growth of the towns on its lines may be augmented and the traffic returns of the company enlarged. The company's industrial department has all the territory traversed by the railroad districted in relation to resources, adaptibility, markets and advantages for manufacturing, and can advise with manufacturers in relation to the most suitable locations. The information furnished a manufacturer is reliable and has practical bearing on the nature of his particular industry. The company makes the resources and advantages along its line known in order to secure more industries, either through the influx of manufacturers about to establish new or branch factories, or through their creation by local enterprise, and makes the manufactured products of the line known in all markets. The company's lines traverse the States of New York, New Jersey, Pennsylvania, Ohio, Indiana and Illinois, all comprising a territory rich in resources and esterprise; many of the most important business centers are immediately upon its tracks; it has great ore docks at Cleveland and Buffalo, and its lines run through the steel manufacturing districts. The geographical location of the Erie Railroad is such as to form a world's thoroughfare quickly commanding all markets—United States and export. Vast deposits of anthracite and bituminous coal, oil, natural gas, sewer-pipe, fire and other clays, cement material, building stone and other minerals exist on the line. The cities on the Erie Railroad are highly enterprising and are thoroughly organized and prepared to treat with manufacturers. New manufacturing plants are constantly locating on the system and the development of local resources is rapidly going on. It is important in this age of modern facilities for manufacturers to locate where they can obtain side tracks so as to receive from and ship directly into cars at the factory. Information can be promptly furnished in this connection about every point on the system between New York and Chicago. The new industrial department is in charge of Luis Jackson, industrial commissioner, Erie Railroad Company, 21 Cortlandt Street, New York.

—The Ingersoll-Sergeant Drill Co. will double its present facilities for manufacturing in the pneumatic tool department. This enlargement is necessary on account of the increasing demand for the Haeseler "Axial Valve" pneumatic hammers.

—The recent great industrial activity has caused many manufacturers to build entirely new works, or at least to greatly extend existing plants. The well-known Pedrick & Ayer Company is one of the many concerns forced by the growth of their business to seek more commodious quarters. For several years this company occupied its own factory in Philadelphia, extending its rapidly growing line of air tools, while continuing its older line of special railroad tools and appliances in which the company gained its reputation. A site for the new modern works was purchased immediately adjoining the Clinton Avenue station of the Central Railroad of New Jersey at Plainfield, N. J. No expense has been spared in the construction and equipment of the buildings, which are all of brick and steel and of slow-burning construction. Good light for all buildings and departments has been especially sought, and convenience to excellent transportation facilities has also been carefully considered. The main building contains the offices of the company, draughting room, tool room and storage room for the principal raw materials and finished parts. The principal portion, however, is taken up by the machine shop proper, the fitting, assembling, testing and shipping departments. The main bay is provided with a 15-ton Shaw electric crane, equipped with three motors. Besides the main traveling crane there are numerous hoists and jib cranes actuated by compressed air. The machine tools are all driven by electric motors, the prevailing plan being to group several machine tools on one countershaft, this in turn being belted to a motor of fair size and efficiency. In the testing department proper arrangements are made to provide practical working conditions for the air compressors, portable and stationary riveters, hoists and cranes, which are produced in great variety and size. At the lower end of the main building a spur from the railroad extends three car lengths under the crane where rapid loading and unloading of machines and products is possible. The boiler and engine house, with fire wall and metal door between, might be considered as one building. The boiler room is well equipped with all necessary appliances dictated by modern usage and has substantial storage capacity for coal. The engine room contains a belted automatic air compressor of the type largely sold by the company, and two direct-connected dynamo-engine sets for supplying power and light to the entire works. The sets are of 150 kilowatts capacity each; the engines are furnished by the Ames Iron Works and the dynamos and switchboards by the General Electric Company. The blacksmith shop and pattern shop and storage house are equally well provided with the accessories for good, reliable, up-to-date work. In fact, the entire plant shows the desire of the Pedrick & Ayer Company to continue its well-established line and still have sufficient capacity to develop improvements for which the buying public is always ready.

—Reference has already been made, in these columns, to the "Technolexikon," the technical dictionary in English, French and

German, which the Society of German Engineers will publish as soon as the necessary matter can be gathered together and put into shape. While this society will bear all the expense of publication, it is hoped that technical societies and individuals in all countries will help to make this monumental work a complete success by sending the editor words, terms and expressions with which they are familiar. In March, 1901, this work was inaugurated by a publication which appeared in the journal of the Society of German Engineers, when the intention to publish such a comprehensive work was first made known generally, and shortly after that printed information was sent to technical societies and individuals in Germany and abroad, telling the ways in which contributions to the "Technolexicon" could be furnished by everybody in touch with the various industries and with technical and engineering work. Dr. Hubert Jansen, whose name has already become connected with other encyclopedic works, was elected editor in charge of this great new undertaking. An idea of the comprehensiveness of the work can be gained from the statement of Dr. Jansen that, although words have already been gathered for one and a half years by societies and individuals in Germany, Belgium, France, England and the United States, the collection will probably not be completed before the end of the year 1904, when the compilation of the contributions will begin, which will occupy about two years more, so that the manuscript will be ready probably by the end of the year 1906, after which it will go to the press. According to Dr. Jansen, not only contributions of technical terms with their translations are desired, but also such contributions which, besides giving the technical term, give, at the same time, an explanation showing in what sense or in what connection the term is used, and contributions of local expressions and customary phrases, as used in the technical language of the country, are highly appreciated. If terms, which are very uncommon, are communicated, it is requested that the derivation be given at the same time. The principal sources for the "Technolexicon" are of course these contributions, but catalogues, price lists and other printed matter of industrial firms, are also of great value, from which catalogues, etc., the technical terms can be gathered by the assistant editors and other collaborators of the editorial staff of the "Technolexicon" in Berlin, and it is highly desirable, therefore, in order to further the work of this dictionary, that all the manufacturing firms publishing catalogues, price lists, etc., send copies of their printed matter to the "Editor of the Technolexicon, Dr. Hubert Jansen, Berlin, N. W. (7), Dorotheenstrasse 49." This will be to the interest of such firms, as the "Technolexicon," once completed, will undoubtedly prove a most valuable help in the work of translating catalogues from one language into another. All those who desire to contribute to this great work through collecting terms and phrases, may apply for note books, especially arranged for that purpose, and for further information directly to Dr. Jansen, or to Dr. Alfred Mueller, of 150 Nassau Street, New York City.

—The New York sales offices of the Nernst Lamp Company have recently been removed from the Equitable Building to the new Hanover Bank Building, No. 11 Pine Street.

—Wm. B. Scaife & Sons Co., of Pittsburg, Pa., sole manufacturers of Scaife and We-Fu-Go water softening and purifying systems, will be represented in the future in Philadelphia by Mr. Duncan W. Patterson, M. E., with offices in the Harrison Building, corner 15th and Market Streets, in place of Mr. Fierstine, whose offices were in the Bourse Building. Mr. Patterson is thoroughly familiar with water purification in all its branches, and he will have charge of all the work of Wm. B. Scaife & Sons Co., in their water purifying department, in Eastern Pennsylvania, Southern New Jersey, Delaware, Maryland, and Virginia.

—The New York Continental Jewell Filtration Co. have recently sold their pressure filters to the following concerns: The Riverside Cotton Mills, Danville, Va.; J. A. Roebling & Sons Co., Trenton, N. J.; Women's College of Baltimore, Baltimore, Md.; American Ice Company, Frankfort, Pa.; Reymann Brewing Company, Wheeling W. Va.; C. W. Franzheim, Wheeling, W. Va.; Reid Plumbing Company, Fairmont, W. Va.; International Text Book Company, Scranton, Pa.

NEW CATALOGUES AND TRADE PUBLICATIONS

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineeting Magazine When you write.

Boilers.

Pamphlet entitled "The Water-Tube Boiler in the American Mercantile Marine" being a reprint of a paper read before the Society of Naval Architects and Marine Engineers by William A. Fairburn. This pamphlet contains illustrated descriptions of various types of marine water-tube boilers and relates experience with them, and also discusses mechanical stokers and oil fuel. 9 by 6 in.; pp. 100. The Stirling Company, Chicago.

Blowers.

Publication No. 154, with illustrated description and price list of a cast-iron exhauster or volume blower direct connected to an electric motor of the protected type. 7 by 6 in.; pp. 4. American Blower Company, Detroit.

Condensing Apparatus.

Pamphlet treating of the condensation of exhaust steam by means of the cooling properties of saturated air, and illustrating and describing the Pennell saturated-air steam condenser, with results of tests. 10 by 7 in.; pp. 14. Arthur Pennell, 300 Heist Building, Kansas City, Mo.

Consulting Engineers.

Booklet, describing the organization and methods of a company which does a general consulting engineering business in all branches, making examinations and tests and furnishing reports. 6¼ by 3½ in.; pp. 12. Engineering Company of America, 74 Broadway, New York.

Correspondence School.

Illustrated catalogue, with detailed descriptions of many courses of instruction by correspondence, in a great variety of subjects, and lists of instructors and graduates. 9½ by 6¾ in.; pp. 184. American School of Correspondence at Armour Institute of Technology, Chicago.

Digging Machinery.

Catalogue for 1903, with descriptions and handsome half-tone illustrations of "orange-peel" and "clam-shell" buckets, dredges, railroad excavators, steel traveling derricks, skid excavators, coal-handling machinery, derrick fixtures, stationary coal bridge, and other kinds of digging and handling appliances. 9¾ by 6½ in.; pp. 143. The Hayward Company, 97-103 Cedar St., New York.

Drills.

Circulars Nos. 2 and 3, with illustrations and descriptions of portable universal radial drills and of plain radial drills. 9 by 6 in.; pp. 4. Roos & Mill, Cincinnati, Ohio.

Electric Apparatus.

Bulletins Nos. 3030 and 6005, devoted, respectively, to sewing-machine motor equipments for direct and alternating currents and to automatic circuit breakers for direct current, with descriptions and many illustrations. 11 by 8 in.; pp. 16. Western Electric Co., Chicago and New York.

Bulletins, with illustrations and descriptions, in French, of hydro-electric plants, generators, motors, lightning arresters, and other electric apparatus. 11½ by 8¾ in.; pp. 4 each. Compagnie de l'Industrie Electrique et Mécanique (Brevets Thury), Geneva, Switzerland.

Electric Driving.

Special publication No. 7008, a paper on "Electrically Driven Shops," by Robert L. Warner, which was presented at a meeting of the New England Railroad Club, and contains well illustrated descriptions of the application of electric motors to the driving of a great variety of machines. 9 by 6 in.; pp. 50. Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Bulletin No. 35, containing a well illustrated description of the new locomotive and car shops of the Lake Shore and Michigan Southern Railway at Collinwood, O., abstracted from the *American Engineer and Railroad Journal.* These shops have a complete electric power equipment for driving tools and for other purposes. 10 by 7½ in.; pp. 34. Crocker-Wheeler Co., Ampere, N. J.

Electric Meters.

Bulletin No. 1, with illustrations and comprehensive descriptions of the Duncan integrating wattmeter and its parts, and information about the installation, testing and maintenance of electric meters and useful tables. 9 by 6 in.; pp. 27. Duncan Electric Mfg. Co., Lafayette, Ind.

Electric Motors.

Publication No. 1044, devoted to small electric motors, with illustrations and descriptions of many kinds of alternating and direct-current motors and their application to a great variety of purposes. 10½ by 8 in.; pp. 60. Also bulletins devoted to various kinds of electric apparatus, and index to bulletins. General Electric Company, Schenectady, N. Y.

Bulletin No. 52, with illustrations and descriptions of the Stow multi-speed electric motors, in which the speed is varied by means of movable cores in the pole pieces, and views of various applications of these motors to driving machinery. 10 by 7 in.; pp. 32. Stow Manufacturing Co., Binghamton, N. Y.

Filtration.

Pamphlet, with description, illustrated with half tones and line cuts, of the filtration works of the East Jersey Water Company at Little Falls, N. J., on the Passaic River, which have a normal capacity of 32,000,000 gallons in 24 hours. 6 by 9 in.; pp. 36. The New York Continental Jewell Filtration Co., New York.

Locomotives.

Record of Recent Construction, No. 43, a pamphlet with tinted illustrations and descriptions in English and in French of a variety of locomotives for different kinds of service representing current requirements. 6 by 9 in.; pp. 32. Baldwin Locomotive Works, Philadelphia.

Machine Tools.

Catalogue No. 36, with illustrated descriptions of patented perforated milling cutter for internal lubrication, milling machines, rotary planing machines, cutting-off machines, boring machines, drilling machines, and other kinds of tools for army, navy, railway and general machine-shop equipment. 9 by 6 in.; pp. 236. Newton Machine Tool Works, Philadelphia.

Mechanical Stoker.

Catalogue "C." with descriptions and illustrations of the Green traveling link grates for securing the progressive combustion of coal under boilers, views of plants where these stokers are installed, and tables giving analyses and other data of coal from all the fields of Pennsylvania, Ohio, Illinois, Indiana and Kentucky. 6½ by 9½ in.; pp. 35. Green Engineering Co., Chicago.

Mining Machinery.

Catalogue No. 19, with large, half-tone illustrations and descriptions of coal cutters and coal drills operated by electricity and compressed air; electric locomotives for mines and surface haulage; complete electric power plants for mining purposes; and coal-handling and washing machinery. 8 by 10 in.; pp. 127. The Jeffrey Manufacturing Co., Columbus, O.

Ore Mills.

Pamphlet, with illustrations and descriptions of the Kinkead ore mill, which has a rotating muller for grinding the ore in a steel pan, and other appliances by means of which the ore is crushed in an economical and efficient manner. 8 by 5¾ in.; pp. 20. Henshaw, Bulkley & Co., San Francisco.

Packing.

Booklet entitled "Points on Packing," with illustrations and descriptions of unvulcanized sheet-rubber packing, gaskets, gasket tubing, union rings, water-cock washers, discs, pump valves and other rubber packing products. 6¼ by 3½ in.; pp. 16. Jenkins Brothers, 71 John St., New York.

Pumps.

Pamphlet, entitled "Pump Data, No. 3," with illustrations and descriptions of the Aldrich vertical quintuplex electric pump, and table showing range of operation. 9 by 6 in.; pp. 8. The Allentown Rolling Mills, Allentown, Pa.

Refrigeration.

"Twentieth Anniversary Greeting," a pamphlet with many illustrations and comprehensive descriptions of complete systems of refrigerating and ice-making machinery for all purposes. 9 by 6 in.; pp. 177. Frick Company, Waynesboro, Pa.

Rubber Matting.

Catalogue, with illustrations, descriptions and prices of corrugated rubber matting, perforated rubber mats and other ornamental door mats, ornamental stair and car step treads, and other kinds of rubber mats and matting. 9 by 6 in.; pp. 24. Boston Belting Co., Boston.

Small Tools.

Catalogue No. 2, with illustrations, descriptions and price lists of taps and dies, die-stock sets, milling cutters, slitting saws, ratchet drills, lathe tools, tapping heads, boiler punches, reamers, taper pins, standard measuring machines, standard size and thread gauges, gauges for railway rolling stock and other special purposes, and other small and special tools. 7¼ by 4¾ in.; pp. 182. Pratt & Whitney Co., Hartford, Conn.

Stamp Mill.

Catalogue with illustrations and descriptions of the improved Parker rotary stamp mill for crushing ores, and of accessory machinery, together with useful tables and data. 8¾ by 5¾ in.; pp. 20. Rotary Mill & Mining Co., Seattle, Wash.

Steam Engines.

Catalogue, with descriptions, illustrated by half-tones and line cuts, of horizontal and vertical automatic high-speed steam engines and their accessories, and tables of dimensions and weights. 7 by 9 in.; pp. 34. New York Safety Steam Power Co., 113 Liberty St., New York.

Structural Work.

Pamphlet, with half-tone illustrations of machine shops, power stations, pier sheds, highway and railway bridges, and other examples of steel and steel-concrete structural work. 4¾ by 8 in.; pp. 47. Berlin Construction Company, Berlin, Conn.

Turbines.

Catalogue M, 1903, with illustrations and descriptions of the "New American" turbine, in many styles, turbine governors, and other water-wheel machinery, paper and pulp mill machinery, gearing, and power transmission machinery, together with results of tests, and tables and other useful information. 9 by 6 in.; pp. 98. Dayton Globe Iron Works Co., Dayton, O.

Unions.

Circular, with illustration and price list of Tuxeda unions for steam pipes. Also, circular illustrating and describing Merrill's "Ideal" twin strainer for condensing water for steam plants. 9½ by 6 in. Franklin Williams, 39 Cortlandt St., New York.

Well Machinery.

Cloth binder, containing various circulars with illustrations and descriptions of Challenge earth auger outfits; St. Louis center beam driller; standard walking-beam outfit for sinking oil, gas and artesian wells; drilling cables and sand lines; portable engines and boilers; and other kinds of well-sinking and drilling machinery. 10¾ by 8¼ in. St. Louis Well Machine & Tool Co., St. Louis.

NEWS SUPPLEMENT

The Engineering Magazine—November, 1903

Coming Society Meetings.

American Association for the Advancement of Science. Sec.: Prof. L. O. Howard, Cosmos Club, Washington, D. C. Annual meeting, week beginning Dec. 8, at St. Louis.

American Boiler Manufacturers' Association. Sec.: J. D. Farasey, Cleveland. Annual convention, November, at Chattanooga.

American Economic Association. Sec.: F. A. Fetter, Ithaca, N. Y. Annual meeting, Dec. 29 to Jan. 1, at New Orleans.

American Institute of Electrical Engineers. Sec.: Ralph W. Pope, 95 Liberty St., New York. Next meeting, Nov. 20, at Carnegie Hall, 154 W. 57th St.

American Railway Engineering and Maintenance of Way Association. Sec.: L. C. Fritch, Monadnock Block, Chicago. Annual meeting, March 15-17, 1904, at Chicago.

American Society of Civil Engineers. Sec.: C. W. Hunt, 220 W. 57th St., New York. Rgeular meetings, first and third Wednesdays of each month, except July and August.

American Society of Heating and Ventilating Engineers. Sec.: W. M. Mackay, 12 W. 31st St., New York. Annual meeting, Jan. 19 to 21, 1904, at New York.

American Society of Mechanical Engineers. Sec.: Prof. F. R. Hutton, 12 W. 31st St., New York. Annual meeting, Dec. 1-4, at New York.

Architectural League of America. Sec.: J. B. Nettleton. Next meeting, April or May, 1904, at Pittsburg.

Boston Society of Civil Engineers. Sec.: S. E. Tinkham, 715 Tremont Temple. Regular meetings on third Wednesday of each month, except July and August.

Brooklyn Engineers' Club. Sec.: J. Strachan, 191 Montague St. Regular meeting, second Thursdays of each month.

Canadian Railway Club. Sec.: W. H. Rosevear, Jr., Montreal. Regular meetings on first Tuesday of each month, except June, July and August.

Canadian Society of Civil Engineers. Sec.: Prof. C. H. McLeod, 877 Dorchester St., Montreal. Regular meetings every alternate Thursday from October to May, inclusive. Electrical Section, Nov. 19. Papers on "Alternating Current Motors for Traction Purposes."

Central Railway Club. Sec.: Harry D. Vought, 62 Liberty St., New York. Regular meetings on second Fridays of Jan., March, May, Sept. and Nov., Hotel Iroquois, Buffalo.

Chicago Electrical Association. Sec.: W. B. Hale, Monadnock Building, Regular meetings on first Friday of each month, from October to May.

Civil Engineers' Club of Cleveland. Sec.: Joseph C. Beardsley, 689 The Arcade. Regular meetings on second and fourth Tuesdays of each month.

Civil Engineers' Society of St. Paul. Sec.: G. S. Edmondstone. Regular meetings on second Monday of each month.

Engineering Association of the South. Sec.: Robt. L. Lund, 2102 Hayes St., Nashville, Tenn. Regular meetings on second Thursday of each month at the Berry Block.

Engineers' Club of Chicago. Sec.: B. W. Thurtell, 1223 New York Life Building. Regular meetings on first and third Tuesdays of each month.

Engineers' Club of Cincinnati. Sec.: J. F. Wilson, P. O. Box 333. Regular meeting on third Thursdav of each month, except July and August.

Engineers' Club of Columbus (Ohio). Sec.: H. M. Gates, 12½ North High St. Regular meetings on first and third Saturdays of each month.

Engineers' Club of Minneapolis. Sec.: Jas. B. Gilman, American Bridge Co. Regular meetings on third Monday of each month.

Engineers' Club of Philadelphia. Sec.: J. O. Clarke, 1122 Girard St. Regular meetings on first and third Saturdays of each month, except July and August.

Engineers' Club of St. Louis. Sec.: H. J. Pfeifer, 920 Rialto Bldg. Regular meetings on first and third Wednesdays of each month.

Engineers' Society of Western New York. Sec.: L. W. Eighmy, 13 City Hall, Buffalo. Regular meetings, first Tuesday of each month, except July and August.

Engineers' Society of Western Pennsylvania. Sec.: Chas. W. Ridinger, 410 Penn Ave., Pittsburg. Regular meetings on third Tuesday of each month.

Franklin Institute. Sec.: Dr. Wm. H. Wahl, 15 South 7th St., Philadelphia. General meetings on third Wednesday of each month, except July and August. General section meetings every Thursday.

Honolulu Engineering Association. Sec.: G. F. Bush, Honolulu, Hawaii.

Iowa Railway Club. Sec.: P. B. Vermillion, Des Moines, Iowa. Regular meetings on third Tuesday of each month.

Louisiana Engineering Society. Sec.: G. W. Lawes, 806 Gravier St., New Orleans. Regular meetings on second Monday of each month.

Montana Society of Engineers. Sec.: Clinton H. Moore, Butte, Mont. Regular meetings on second Saturday in each month.

National Electric Light Association. Sec.: Ernest H. Davis, 136 Liberty St., New York. Annual convention in May, at Boston.

New England Railroad Club. Sec.: Edw. L. Janes, Back Bay P. O., Boston. Regular meetings, second Tuesday in each month, except June, July, August and September, at Pierce Hall, Copley Square.

New York Electrical Society. Sec.: Geo. H. Guy, 114 Liberty St., New York. Meetings monthly, on different Wednesdays, American Institute, 19 W. 44th St.

New York Railroad Club. Sec.: F. M. Whyte, Grand Central Station, N. Y. City. Regular meetings on third Friday of each month, except June, July, and August, at Carnegie Hall, 154 W. 57th St., New York.

New York Street Railway Association. Sec.: W. W. Cole, Elmira. Annual meeting, Sept., 1904, at Utica.

Northwestern Electrical Association. Sec.: Thos. R. Mercein, Milwaukee. Annual convention, Jan. 20, at Milwaukee.

North-West Railway Club. Sec.: T. W. Flannagan, Minneapolis, Minn. Regular meetings on first Tuesday after second Monday of each month, except June, July and August, alternating between Minneapolis and St. Paul.

Pacific Coast Electrical Transmission Association. Sec.: Geo. P. Low, 302 Rialto Building, San Francisco.

Pacific Coast Railway Club. Sec.: C. C. Borton, West Oakland, Cal. Regular meetings on third Saturday of each month at San Francisco and other cities.

Pacific Northwest Society of Engineers. Sec.: G. F. Cotterill, Seattle, Wash. Meetings monthly in Chamber of Commerce rooms, Seattle.

Railway Club of Pittsburg. Sec.: J. D. Conway, P. & L. E. R. R., Pittsburg, Pa. Regular meetings on fourth Friday of each month, except June, July and August, at Hotel Henry.

Railway Signaling Club. Sec.: B. B. Adams, 83 Fulton St., New York. Regular meetings on second Tuesday of January, March, May, Sept. and Nov. Annual meeting, Nov 10, at Detroit.

Richmond Railroad Club. Sec.: F. O. Robinson, 8th & Main Sts., Richmond, Va. Regular meetings on second Thursday of each month, except June, July and August.

Rocky Mountain Railway Club. Sec.: M. M. Currier, Colorado City. Regular meetings on first Saturday after the 15th of each month, at Union Depot, Denver.

St. Louis Railway Club. Sec.: E. A. Chenery, Union Station, St. Louis. Regular meetings on second Friday of each month, except July and August.

Society of Chemical Industry, New York Section. Sec.: H. Schweitzer, 40 Stone St. Meetings on third Friday after the first Monday of each month, at Chemists' Club, 108 W. 55th St.

Society of Naval Architects and Marine Engineers. Sec.: W. L. Capps, 12 W. 31st St., New York. Annual meeting, Nov. 19 and 20, at 12 W. 31st St., New York.

Southern and Southwestern Railway Club. Sec.: W. A. Love, Atlanta, Ga. Regular meetings on third Thursday of Jan., April, Aug. and Nov., at Atlanta.

Technical Society of the Pacific Coast. Sec.: Otto von Geldern, 31 Post St., San Francisco. Regular meetings on first Friday of each month.

Texas Railway Club. Sec.: T. H. Osborne, Pine Bluff, Ark. Regular meetings on third Monday of April and September.

Western Railway Club. Sec.: Jos. W. Taylor, 667 Rookery, Chicago. Meetings on third Tuesday of each month, except June, July and August, Auditorium Hotel, Chicago.

Western Society of Engineers. Sec.: J. H. Warder, Monadnock Block, Chicago. Regular meetings on first Wednesday and extra meetings on third Wednesday of each month, except July and August.

Personal.

—Mr. C. F. Quincy has been elected president of The Railway Appliances Company, in place of Mr. H. K. Gilbert, who has resigned. Mr. Geo. H. Sargent has been elected vice-president, and Mr. Percival Manchester, secretary and treasurer.

—Mr. A. W. Henshaw, formerly of the General Electric Company, Schenectady, N. Y., will henceforth have charge of the Motor Department of the Stanley Electric Mfg. Co., of Pittsfield, Mass.

—Mr. E. W. Roberts, who is well known to the gas-engine trade as a designer and consulting engineer, and as the author of the "Gas-Engine Handbook" and numerous other works on gas engines and automobiles, is fitting up a laboratory at Clyde, Ohio, for the testing of gas and gasoline engines and gasoline automobiles, as well as for calorimetry and analysis of both gas and liquid fuels.

—The members of the Mosely Educational Commission, who arrived in New York early in October, are now actively engaged in investigating all branches of the American educational system, upon which they will report when they return to England.

Industrial Notes.

—The forty-ninth annual report of the Lehigh Valley Railroad Company, for the fiscal year ending June 30, 1903, shows the road to be in a very satisfactory condition. The gross earnings increased 11.43 per cent. over the preceding twelve months and the operating expenses increased 5.56 per cent., while the ratio of expenses to earnings was 71.21 per cent., being a decrease as compared with the last fiscal year of 3.96 per cent.

—The Allis-Chalmers Co., of Chicago, received the contract for the new pump in the Turkey Creek pumping station at Kansas City, Mo. The engine complete has a capacity of 16 million gallons per day, and went into operation in October.

—The National Battery Fan Company, of 14 South Broad St., Philadelphia, has produced a new dry electric battery, which possesses all the good points of the primary battery and at the same time is capable of being recharged like a storage battery, and can be shipped like ordinary merchandise by express or freight to any part of the country. The great advantage of this will be at once apparent, as it permits the furnishing of electric power for fans and other small machines at any point in city or country, thus opening up a field which heretofore could not be reached. The National Battery Fan Co., are desirous of appointing sub-agents throughout the United States, and they will furnish full particulars upon request.

—The Canadian Society of Civil Engineers has lately organized an Electrical Section, the first meeting of which was held on October 15, the special subject for the evening being "The Electrical Equipment of some Canadian Hydro-Electric Plants," introduced in a paper by Mr. R. S. Kelsch, M. Can. Soc. C. E., on "The Reorganization of the Lachine Rapids Hydraulic and Land Company's Power Station," illustrated by lantern projections. There will be other meetings of this section on November 19, January 7, February 11, March 18 and April 17, when papers on various subjects of live interest will be read and discussed.

—Two recent and important contracts by the Union Switch & Signal Company are those for the Interborough Rapid Transit Company (Subway), of New York, and the North Shore Railway of California. The Westinghouse electro-pneumatic system is to be installed on the first named, but a new feature is to be introduced, that of using alternating current. It is obvious that the use of track circuits on third-rail roads, where the rails are used for the return circuit, and at the same time for the signalling circuit, introduces what may be serious complications. In order to avoid these difficulties, the signals will be controlled by alternating current, through relays that are sensitive to alternating current only, and which will not be affected by the direct current used for train service in the subway. On the North Shore Railway, which runs about thirty miles north from Sausalito, California, across the bay from San Francisco, the electric semaphore system of automatic block signals is to be used with a track circuit. This being a high-tension, third-rail electric road, alternating current will be used for the signal system.

—The Pelton Water Wheel Company, of San Francisco, report a splendid business in the manufacture of water wheels. Their plant is working night and day to keep up with the orders. Among the important contracts closed during the past few months for hydro-electric plants, are the following, which aggregate 56,400 horse-power: American River Electric Company, Placerville, Cal., head 575 feet, two double Pelton units, each of 2,500 horse-power capacity. Pike's Peak Hydro-Electric Company, Colorado Springs, Colo., head 2,200 feet, three Pelton wheels, each of 1,500 horse-power capacity. Columbia Improvement Company, Tacoma, Wash., head 850 feet, four Pelton units, each of 7,500 horse-power capacity. Vancouver Power Company, Vancouver, B. C., head 390 feet, three double Pelton units, each of 3,000 horse-power capacity. Northern California Power Company, Anderson, Cal., head 1,150 feet, two double Pelton units, each of 3,000 horse-power capacity. Rock Creek Power and Transmission Company, Baker City, Ore., head 960 feet, two Pelton units, aggregating 1,760 horse-power. Columbus Consolidated Mining Company, one Pelton unit, 494 feet, 660 horse-power capacity. The above is indicative of the flexibility, both as to head and power, of the Pelton system, as well as of the high regard in which the Pelton wheels are held by engineers.

—James Bonar & Co., Inc., announce to their patrons and the trade that they have been duly incorporated under the laws of the State of Pennsylvania, and have taken over the business heretofore known as James Bonar & Co., of Pittsburg. They will continue to manufacture and handle a full line of first-class steam appliances, adding to the number from time to time as may be necessary to make their line the most complete in this part of the country. They are now erecting a first-class machine shop and brass foundry on their own property at 40th street and A. V. R. R., Pittsburg. This shop is for the purpose of manufacturing their own specialties, and also other machine work. The machinery will be new and of the most modern design, and will be specially adapted to the manufacturing of special work. In addition to this, the shop will be equipped with a modern steam plant, in which is included a special high-pressure boiler for testing purposes, as in the past they have felt the need of such facilities for testing high pressure work. They will therefore be in a position to accept the manufacturing of special work to be used in high pressure, making and testing it complete under actual working conditions before leaving their shops.

—The Canadian Westinghouse Company, Limited, was organized with a capital of $2,500,000 at a meeting held recently at Hamilton, Ontario, and presided over by Mr. George Westinghouse. The new company is a consolidation of all the Westinghouse interests in Canada, which heretofore have been conducted individually. It will take over all the property, patents, and other interests of the succeeded companies, including the sales organization and business of Ahearn & Soper, of Ottawa.

—The Power Specialty Company, among the more important contracts for the installation of their Foster superheaters in electric power stations, report the following work nearing completion: Quincy Station, Old Colony Street Railway Co., Massachusetts Electric Railway; Hartford Electric Light Co., Hartford, Conn.; The Interborough Rapid Transit Co., (New York Underground); Independent Light & Power Co., Quincy, Ill.; The Belt Light & Power Co., Lead, S. D.; Omaha Electric Light & Power Co., Omaha, Neb., and the New York Central Railway Co.

—An immense artificial cascade has been determined upon by the authorities of the Louisiana Purchase Exposition as the center-piece of the semi-circular lay-out of the principal buildings. The cascade itself will be divided into three parts; a large middle cascade with a smaller one at each side, the water flowing directly into the head of the Grand Basin. In all, about 90,000 gallons of water per minute will be supplied at a head of 159 feet, forming the greatest artificial water effect ever attempted. The water will be taken from the Grand Basin itself and will be raised to the top of the cascade by a pumping station located under Festival Hall. The pumping machinery will consist of three 36-inch, single-stage, turbine centrifugal pumps purchased from Henry R. Worthington, of New York City, each driven by a 2,000-horse-power Westinghouse alternating current motor. The total horse-power utilized will thus be 6,000, making this the largest electric pumping station in the world. The pumps and other pieces of machinery for this plant are now being installed at St. Louis.

—The Stanley Electric Mfg. Co., of Pittsfield, Mass., announce the opening of two new sales offices, one at Cincinnati, with headquarters in the Perin Building, in charge of Mr. O. H. P. Fant, and the other in the Century building, St. Louis, Mo., in charge of Mr. F. Johnson.

—Sargent, Conant & Co., Equitable Bldg., Boston, Mass., have recently completed the installation of an electric lighting and power system for the town of Groton, Conn., and will shortly begin work on a similar equipment for the town of Millers Falls, Mass.

—The Reeves Engine Company shipped seventeen engines, aggregating over 3,000 H. P., during the month of September. All but two of these engines are of the Reeves vertical, cross-compound type, and, with the exception of one 400-H. P. and one 30-H. P. machine, they are for direct connection to electric generators, the two mentioned being designed for power purposes. This is a fine showing considering the fact that the Reeves Engine Co. have been exploiting their product really less than a year.

—A report made by Professor Chamot, on the water furnished to Cornell University by the new filtration plant, shows that the water supply of Cornell is now all that can be desired.

—The Jenney Electric Mfg. Co., of Indianapolis, in order to substantiate their claim that the "Jenney" Linotype Motor is superior in design, efficiency and economical operation, to any on the market, will send their motor to any responsible printing establishment for a thirty-day trial, under a guarantee that it will fully meet the above requirements.

—The Diamond Machine Company, of Providence, R. I., announce that they have purchased the patents, patterns and drawings of the Gorton disk grinders, and will manufacture the full line, twenty-three machines, at their works in Providence, R. I. The shops of the Gorton Machine Co. will probably be employed upon the construction of mining machines embodying important improvements.

—The Carborundum Company is again making enlargements of its plant at Niagara Falls, a fact which is of special interest in illustrating the growth of an entirely new industry. Carborundum was invented in 1891. The first commercial furnace of the company had a capacity of a quarter of a pound a day, and the first sale made was a little lot of twenty carats, sent out on an order from a jewelry house, at a price of 25 cents a carat, equal to $450 a pound. These small furnaces sufficed to supply all demands for the new abrasive for nearly two years, when they were replaced by what seemed at that time to be enormous furnaces, requiring the use of 150 electrical horse power. In 1896 the company built its plant at Niagara Falls, employing furnaces using 1,000 electrical horse-power, with a capacity far in excess of the demands at that time. By 1900 the demand had more than caught up with the production, however, and the capacity was doubled. Last year another 1,000 electrical horse-power was added, but the growth of the business has been so rapid that even with 3,000 electrical horse-power, the company has for months, been unable to fill its orders. A contract has now been made for 2,000 more electrical horse-power, and this will be turned into the works by December of this year, giving the plant a capacity of about ten million pounds of carborundum per annum.

—The Brooklyn Engineers' Club held the first meeting of the season on the evening of October 8th. Besides the usual formal business, a very interesting paper, entitled "A History of Pumps, Ancient and Modern," was read by Mr. John A. Drew, of the Worthington Company. Mr. Drew sketched the development of pumping machines from the early Egyptian "Noria," resembling the familiar well sweep, to the latest triple-expansion, condensing, water-works pumping engines, requiring little more than a pound of coal per horse-power-hour. The paper was illustrated by a large number of lantern slides.

—The Diamond Drill & Machine Co., of Birdsboro, Pa., have opened an office in Pittsburg, in the Farmers' Bank Building, in charge of Mr. G. B. Nutt, the Pittsburg representative of Pilling & Crane, Pilling & Crane being their Pittsburg agents.

—The Nernst Lamp Company, of Pittsburg, has recently established an agency for the sale of Nernst lamps and supplies with The W. G. Nagel Company, Toledo, Ohio; the latter company having, for several years, acted as selling agents for the Westinghouse Electric & Mfg. Co.

—The Brown Corliss Engine Co., of Corliss, Wis., have received an order from the Lorain Steel Co., of Lorain, Ohio, for a 30 and 60 by 60-inch cross-compound Corliss engine.

—President Engler, of the Worcester Polytechnic Institute, while in New York recently had a conference with a number of the leading foundrymen from different parts of the country respecting the building and exhibit which the latter propose to have at the St. Louis Exposition next year. At that time it is proposed to erect and operate a model foundry, fully equipped with all necessary apparatus, and exhibiting in operation all the processes of modern foundry practice. An advisory committee, consisting of many of the prominent foundry experts in the country, has been appointed to organize the work, and of this committee President Engler is a member. The Worcester Polytechnic Institute has been invited to prepare complete plans for the building, having in mind special reference to ideal conditions as to light, heat, ventilation and sanitation, and to a maximum of economy and efficiency by convenience of arrangement and use of the best modern devices in machinery and methods. Besides furnishing space for all ordinary operations in iron, brass, aluminum, steel and lead, the building is to provide accommodations for a chemical laboratory, an exhibition room, a library and reading room, toilet room and shower baths. This foundry exhibit is designed to be primarily educational in its character, and during the entire time while it is in operation at St. Louis, it will be under the direction and charge of the Worcester Polytechnic Institute. The invitation to design the building comes to the Worcester Polytechnic Institute as a result of the erection, a little over a year ago, of the new foundry building there, which is acknowledged by all to be the best and most complete plant of its kind in the United States.

—The National Motor Boat Exposition will be held February 8th to 20th, 1904, at the new and spacious Herald Square Exhibition Hall, at the junction of Broadway, 34th Street and Sixth Avenue, New York. Dr. Robert Taylor, the director of the Motor Boat Show, has already a list of about thirteen hundred concerns which manufacture motor boats. The distribution of the preliminary prospectus sent out by the management of the Motor Boat Show, brought quick responses expressing the interest of makers of motor boats, motors and auxiliaries, and the prospect is bright, not only for a first show of motor boats, but for its annual repetition.

—Williams Hall, of Lehigh University, South Bethlehem, Pa., which was formally opened in connection with the annual celebration of Founder's Day, on October 8, is situated in the University Park, on the hillside to the rear of the Chemical and the Physical Laboratories, midway between them; its front is in line with the Library. The building is 186 feet long by 70 feet wide; the area of each floor is over 12,000 are feet. The walls are constructed of brick and cement ornamented by carved stone work, and the building is of "Mill" or slow-burning construction. One-half of this building will be devoted to the department of Geology and the other half to the department of Mechanical Engineering. The entire building is thoroughly heated and ventilated by approved modern methods. Williams Hall is named in honor of the principal donor, Prof. E. H. Williams, Jr., of the department of Geology and Mining.

—The *Navy League Journal* for October is an interesting number. It shows as the frontispiece the battleship Illinois, and the portrait of Commodore McDonough is on the cover. Among the notable articles are: 1. "The Splendid Achievements of the American Navy," which recites some of the triumphs of the Navy in the past. 2. "Memorandum of a Naval Staff," by Rear-Admiral H. C. Taylor. 3. "The German Navy League," by Frederick W. Catlin. 4. "Old Ironsides," by Paul Dyer Emmons; with a picture of the Constitution as she appears now in Charlestown navy yard, and a picture of the fight between the Constitution and the Guerrière. 5. "The New Department of Commerce and Labor," with portrait of Hon. George B. Cortelyou, Secretary. 6. "The Naming of our Battleships." 7. "An Object Lesson for Germany." 8. "Rear-Admiral C. W. Rea, Chief Engineer of the Navy;" with portrait. There is a fine picture of the launching of the armored cruiser Pennsylvania and of the gigantic crane, hoisting the turret on the Florida. The Navy League is evidently bound to become a great power in the land, and a list of Sections of the League already established, shows that nearly every large city in the country is interested. The German Navy League has 626,000 members. The British Navy League has nearly half a million and the French Navy League has a large and growing membership and the support of the most distinguished citizens of France. All of these Navy Leagues are exerting a powerful influence in favor of liberal appropriations for new ships. The Navy League of the United States, whose headquarters are at 32 Broadway, New York, should have at least as many members as the foreign organizations.

NEW CATALOGUES AND TRADE PUBLICATIONS

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine When you write.

Automobiles.

The White Bulletin, No. 1, with well illustrated and interesting accounts of the excellent performances of the White steam touring car on track and road, with descriptions of some notable tours made in these steam vehicles. 9¼ by 6¼ in.; pp. 16. White Sewing Machine Co., Cleveland.

Belting.

Pamphlet, with half-tone illustrations and descriptions of high-grade leather belting, belt fastenings, belt dressing, cotton belting, rubber belting, hose, packing, rubber gloves and mittens, and many other kinds of leather and rubber goods. 7½ by 5 in.; pp. 110. J. E. Rhoads & Sons, Philadelphia.

Boring Mills.

Circular, with illustrated description of 8-foot, and other sizes of vertical boring and turning mills, with all the modern improvements, and especially adapted for electric driving. 9 by 6 in.; pp. 4. The J. Morton Poole Co., Wilmington, Del.

Carborundum.

Catalogue No. 4, with handsome illustrations, articles on the manufacture and development of carborundum, a combination of carbon and silicon, accounts of its employment for all kinds of abrasive work and for a variety of other uses, and descriptions of the many forms in which it is manufactured, with telegraph code and general information. 9 by 6½ in.; pp. 88. The Carborundum Co., Niagara Falls, N. Y.

Concrete Mixers.

Catalogue No. 12, with fully illustrated descriptions of the portable gravity concrete mixer, which consists of an inclined steel trough filled with numerous rows of steel pins, staggered to mix thoroughly the sand, cement and broken stone as they pass through, with views of numerous installations of this mixer, and useful information about the various kinds of cement. 4½ by 7½ in.; pp. 64. Contractors Plant Company, Incorporated. Boston.

Conveyors.

Catalogue, with descriptions and half-tone illustrations of shallow-trough belt conveyors, of rubber and cotton, and views of various installations of them; and also, illustrated descriptions of coal and coke crushers. 9 by 6 in.; pp. 27. The Link-Belt Engineering Co., Nicetown, Philadelphia.

Drills.

Catalogue, with illustrations and descriptions of rock and coal drills, both percussion and rotary, operated by steam, compressed air, electricity and hand power, electric mine pumps and hoists, coal-cutting machines, and other mining and conveying machinery. 9 by 6 in.; pp. 40. The Jeffrey Manufacturing Co., Columbus, O.

Dynamos.

Special bulletin, with description and half-tone illustrations of electric generators for railway service and their parts. 10¼ by 7¼ in.; pp. 4. Crocker-Wheeler Company, Ampere, N. J.

Electric Conduits.

Bulletin No. 411, second edition, with illustrations and descriptions of iron-armored insulating conduit for electric conductors, junction boxes, fittings and tools for electric conduit work, together with telegraph code. 9¼ by 7 in.; pp. 48. Sprague Electric Co., 527-531 W. 34th St., New York.

Electric-Motor Starters.

Illustrated circular showing how closely the Ward Leonard electric-motor starting rheostats and switches conform to the United States Navy specifications, and giving a few of the patent claims in this field granted to H. Ward Leonard. 16½ by 9¼ in. Ward Leonard Electric Co., Bronxville, N. Y.

Electric Supplies.

Catalogue, with descriptions and half-tone illustrations of incandescent lamp sockets, both standard and in special finishes, receptacles, rosettes, flush plates, switches, cut-outs, fuses, and many other kinds of electric supplies, together with telegraph code. 3¼ by 6½ in.; pp. 189. The Perkins Electric Switch Mfg. Co., Bridgeport, Conn.

Escalator.

Circular, with illustrations and descriptions of the escalator, or moving staircase, in operation at elevated railway stations and in stores, and which carries a great number of passengers quickly, conveniently and safely. 9 by 7¼ in.; pp. 4. Otis Elevator Company, New York.

Feed-Water Heaters.

Catalogue, with fully illustrated descriptions of the Pittsburgh feed-water heater and purifier, both the open and the closed types, and the Pittsburgh combined feed-water heater and receiver, with all their details; and descriptions and illustrations of the Bonar gauge cock and Bonar oil filters. 9 by 6 in.; pp. 48. James Bonar & Co., Inc., Pittsburg.

Machinery Supplies.

Sheets and circulars, with illustrations, descriptions and prices of portable forges, blacksmiths' blowers, upright post drills, self-opening adjustable dies, die screw plates, and die stocks, reversible ratchet wrenches, Smith adjustable gaskets, and many other kinds of machinery and supplies. Somers, Fitler & Todd Co., Pittsburg.

Machine Tools.

Catalogue and price list No. 2, with illustrated descriptions of improved shaping machines, upright, hand and power drills for a variety of purposes, bolt-cutting and nut-tapping machines, portable forges, tire benders, tire shrinkers, bolt headers, and many other machines and tools, together with lists of all duplicate parts for repairs and complete telegraphic code. 9 by 6 in.; pp. 116. Boynton & Plummer, Worcester, Mass.

Mining Machinery.

Catalogue No. 48, devoted to modern methods of producing coal, with half-tone illustrations and descriptions of all kinds of coal-mining machinery, and useful tables and information. 9 by 6 in.; pp. 154. Also, catalogue No. 49, illustrating and describing diamond drills for the rapid and economical prospecting of mines and mineral and quarry lands. 9 by 6 in.; pp. 152. Sullivan Machinery Company, Chicago.

Nernst Lamp.

Special publication N-7000, containing a well illustrated treatise on the Nernst lamp, which emits a remarkably steady and efficient light on the passage of an electric current through a "glower" composed of oxides of the rare earths, with curves and diagrams showing its operation, and views of places where it is in use. 9 by 6 in.; pp. 24. Nernst Lamp Co., Pittsburg.

Oilers.

Treatise on "How to Oil an Engine," and illustrated catalogue with descriptions of Nugent's patent pendulum crank-pin center oilers, loose pulley oilers, anti-packed telescopic oilers for crank-pins, crosshead pins and eccentrics, oil pumps, oil filters, and other devices for oiling machinery, and also of a reducing motion for steam-engine indicators. 9 by 6 in.; pp. 48. Wm. W. Nugent & Co., Chicago.

Packing.

Booklet devoted to Eagleine special packings, such as ring, pump, square hydraulic, asbestos, ammonia and many other kinds for a great variety of uses. Also booklets devoted, respectively, to Eagleine Hold Fast belt dressing, U. S. Standard boiler compound, and a premium list of useful articles for engineers. Eagle Oil and Supply Co., Boston.

Pneumatic Tools.

Circular No. 42, with illustrations and descriptions of the Chicago plug drill for making holes in quarry and stone work in a rapid and economical manner, the Chicago rock drill, and the Boyer pistol-grip, straight-handle and valveless stone hammers for stone carving, cutting and dressing. 11 by 8½ in.; pp. 4. Chicago Pneumatic Tool Co., Chicago and New York.

Screens.

Catalogue No. 8, with illustrations and description of a flat impact screen for screening and sizing wet or dry ores from 4 to 80 mesh, together with plans for setting one or more of such screens. 9½ by 6½ in.; pp. 16. The Colorado Iron Works Co., Denver.

Steam Power Plants.

Pamphlet, with half-tone illustrations and descriptions of steam power plants which have been installed on the Pacific Coast and the Hawaiian Islands for electric railways, office buildings, university buildings, and many other places, together with high-grade apparatus and machinery for such plants. 8 by 6 in.; pp. 100. Chas. C. Moore & Co., Engineers, San Francisco.

Telpherage.

Circular No. 39, with illustrations and descriptions of the convenient and economical handling by the electric telpherage system, of miscellaneous freight for railroad and steamship companies at terminal stations, including hoisting, conveying, lowering and tiering. 9 by 6 in.; pp. 12. Also, circular No. 40, showing the application of the telpherage system to storing and handling coal, coke and ashes. 9 by 6 in.; pp. 4. United Telpherage Co., 20-22 Broad St., New York.

Time Recorders.

Illustrated folder, devoted to the Cincinnati time recorder for registering the time of employees. 6 by 3½ in.; pp. 6. Selling Agents, American Watchman's Time Detector Co., Cleveland.

Turbines.

Catalogue of the Trump "model" turbine for low and medium heads and of high grade turbines for heads ranging from 30 to 300 feet, with illustrations of turbines, their parts and their manufacture, plants in various parts of the world where they are installed, descriptive text in English, Italian and Swedish, and useful tables and information. 6 by 9 in.; pp. 80. Trump Manufacturing Co., Springfield, O.

Water-Wheel Governors.

Catalogue devoted to turbine water-wheel governors, with completely illustrated descriptions of different types which are operated by means of oil or water under pressure, switchboard controlling apparatus, methods of connecting governors to water-wheel gates, and principles and general information concerning the speed regulation of water-power plants. 9 by 6 in.; pp. 44. Sturgess Governor Engineering Co., West Troy, N. Y.

Well Machinery.

Circular, form 89, containing sample pages from a larger catalogue, with illustrations, descriptions and prices of jetting well-sinking rigs, elliptical jetting drilling machines, revolving hydraulic well-sinking machines, heavy rotary boring outfits, cable elliptical drilling machines, well auger outfits, pumping engines, well-drilling tools of "adamantine," a new metallic composition, and many other kinds of well-sinking machinery and appliances therefor. 9 by 6 in.; pp. 32. American Well Works, Aurora, Ill.

Wire Rope.

Catalogue and price list E, with illustrations and descriptions of wire rope and cordage of all kinds, sockets, hooks, clips, blocks, sheaves and many other appliances for wire-rope transmission installations. 6 by 3½ in.; pp. 52. Broderick & Bascom Rope Co., St. Louis, Mo.

NEWS SUPPLEMENT

The Engineering Magazine—December, 1903

Coming Society Meetings.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE. Sec.: Prof. L. O Howard, Cosmos Club, Washington, D. C. Annual meeting, Dec. 28-Jan. 2, at St. Louis.

AMERICAN ECONOMIC ASSOCIATION. Sec.: F. A. Fetter, Ithaca, N. Y. Annual meeting, Dec. 29 to Jan. 1, at New Orleans.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS. Sec.: Ralph W. Pope, 95 Liberty St., New York. Next meeting, December 18, at Carnegie Hall, 154 W. 57th St., New York.

AMERICAN INSTITUTE, POLYTECHNIC SECTION. Sec.: George Whitefield, Jr., 19 W. 44th St., New York. Meetings on first and third Thursdays of each month, from October to May, inclusive.

AMERICAN RAILWAY ASSOCIATION. Sec.: W. F. Allen, 24 Park Place, New York Next meeting, April 27, at New York.

AMERICAN RAILWAY ENGINEERING AND MAINTENANCE OF WAY ASSOCIATION. Sec.: L. C. Fritch, Monadnock Block, Chicago. Annual meeting, March 15-17, 1904, at Chicago.

AMERICAN SOCIETY OF CIVIL ENGINEERS. Sec.; C. W. Hunt, 220 W. 57th St., New York. Regular meetings, first and third Wednesdays of each month, except July and August. Annual meeting, Jan. 20.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS. Sec.: W. M. Mackay, 12 W. 31st St., New York. Annual meeting, Jan. 19 to 21, 1904, at New York.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Sec.: Prof. F. R. Hutton, 12 W. 31st St., New York. Annual meeting, Dec. 1-4, at New York.

ARCHITECTURAL LEAGUE OF AMERICA. Sec.: J. B. Nettleton. Next meeting, April or May, 1904, at Pittsburg.

BOSTON SOCIETY OF CIVIL ENGINEERS. Sec.: S. E. Tinkham, 715 Tremont Temple. Regular meetings on third Wednesday of each month, except July and August.

BROOKLYN ENGINEERS' CLUB. Sec.: J. Strachan, 191 Montague St. Regular meetings on second Thursdays of each month.

CANADIAN RAILWAY CLUB. Sec.: W. H. Rosevear, Jr., Montreal. Regular meetings on first Tuesday of each month, except June, July and August.

CANADIAN SOCIETY OF CIVIL ENGINEERS. Sec.: Prof. C. H. McLeod, 877 Dorchester St., Montreal. Meeting of General Section, Dec. 10. Electrical, Mechanical and Mining Sections meet on different Thursdays.

CENTRAL RAILWAY CLUB. Sec.: Harry D. Vought, 62 Liberty St., New York. Regular meetings on second Fridays of Jan., March May, Sept. and Nov., Hotel Iroquois, Buffalo.

CHICAGO ELECTRICAL ASSOCIATION. Sec.: W. B. Hale, Monadnock Building. Regular meetings on first and third Fridays of each month, from October to May.

CIVIL ENGINEERS' CLUB OF CLEVELAND. Sec.: Josepn C. Beardsley, 689 The Arcade. Regular meetings on second and fourth Tuesdays of each month.

CIVIL ENGINEERS' SOCIETY OF ST. PAUL. Sec.: G. S. Edmondstone. Regular meetings on second Monday of each month.

ENGINEERING ASSOCIATION OF THE SOUTH. Sec.: Robt. L. Lund, 2102 Hayes St., Nashville, Tenn. Regular meetings on second Thursday of each month at the Berry Block.

ENGINEERS' CLUB OF CHICAGO. Sec.: B. W. Thurtell, 1223 New York Life Building Regular meetings on first and third Tuesdays of each month.

ENGINEERS' CLUB OF CINCINNATI. Sec.: J. F. Wilson, P. O. Box 333. Regular meeting on third Thursday of each month, except July and August.

ENGINEERS' CLUB OF COLUMBUS (OHIO). Sec.: H. M. Gates, 12½ North High St. Regular meetings on first and third Saturdays of each month.

ENGINEERS' CLUB OF MINNEAPOLIS. Sec.: Jas. B. Gilman, American Bridge Co. Regular meetings on third Monday of each month.

ENGINEERS' CLUB OF PHILADELPHIA. Sec.: J. O. Clarke, 1122 Girard St. Regular meetings on first and third Saturdays of each month, except July and August.

ENGINEERS' CLUB OF ST. LOUIS. Sec.: H. J. Pfeifer, 920 Rialto Bldg. Regular meetings on first and third Wednesdays.

ENGINEERS' SOCIETY OF WESTERN NEW YORK. Sec.: L. W. Eighmy, 13 City Hall, Buffalo. Regular meetings, first Tuesday of each month, except July and August.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA. Sec.: Chas. W. Ridinger, 410 Penn Ave., Pittsburg. Regular meetings on third Tuesday of each month.

FRANKLIN INSTITUTE. Sec.: Dr. Wm. H. Wahl, 15 South 7th St., Philadelphia. General meetings on third Wednesday of each month, except July and August. General section meetings every Thursday.

HONOLULU ENGINEERING ASSOCIATION. Sec.: G. F. Bush, Honolulu, Hawaii.

IOWA RAILWAY CLUB. Sec.: P. B. Vermillion, Des Moines, Iowa. Regular meetings on third Tuesday of each month.

Louisiana Engineering Society. Sec.: G. W. Lawes, 806 Gravier St., New Orleans. Regular meetings on second Monday of each month.

Montana Society of Engineers. Sec.: Clinton H. Moore, Butte, Mont. Regular meetings on second Saturdays.

National Electric Light Association. Sec.: Ernest H. Davis, 136 Liberty St., New York. Annual convention in May, at Boston.

New England Railroad Club. Sec.: Edw. L. Janes, Back Bay P. O., Boston. Regular meetings, second Tuesday in each month, except June, July, August, and September, at Pierce Hall, Copley Square.

New Jersey Sanitary Association. Sec.: J. A. Exton, Arlington, N. J. Annual meeting, Dec. 4 and 5, at Lakewood.

New York Electrical Society. Sec.: Geo. H. Guy, 114 Liberty St., New York. Meetings monthly, on different Wednesdays, at the American Institute, 19 W. 44th St.

New York Railroad Club. Sec.: F. M. Whyte, Grand Central Station, N. Y. City. Regular meetings on third Friday of each month, except June, July, and August, at Carnegie Hall, 154 W. 57th St., New York.

New York Street Railway Association. Sec.: W. W. Cole, Elmira. Annual meeting, Sept., 1904, at Utica.

Northwestern Electrical Association. Sec.: Thos. R. Mercein, Milwaukee. Annual convention, Jan. 20, at Milwaukee.

North-West Railway Club. Sec.: T. W. Flannagan, Minneapolis, Minn. Regular meetings on first Tuesday after second Monday of each month, except June, July and August, alternating between Minneapolis and St. Paul.

Pacific Coast Electrical Transmission Association. Sec.: Geo. P. Low, 237 Cherry St., San Francisco. Annual convention, third Tuesday in June. Intermediate meetings subject to call.

Pacific Coast Railway Club. Sec.: C. C. Borton, West Oakland, Cal. Regular meetings on third Saturday of each month at San Francisco and other cities.

Pacific Northwest Society of Engineers. Sec.: G. F. Cotterill, Seattle, Wash. Meetings monthly in Chamber of Commerce rooms, Seattle.

Railway Club of Pittsburg. Sec.: J. D. Conway, P. & L. E. R. R., Pittsburg, Pa. Regular meetings on fourth Friday of each month, except June, July and August, at Hotel Henry.

Railway Signal Association. Sec.: B. B. Adams, 83 Fulton St., New York. Regular meetings on second Tuesday of January, March, May, Sept. and Nov.

Richmond Railroad Club. Sec.: F. O. Robinson, 8th & Main Sts., Richmond, Va. Regular meetings on second Thursday of each month, except June, July and August.

Rocky Mountain Railway Club. Sec.: M. M. Currier, Colorado City. Regular meetings on first Saturday after the 15th of each month, at Union Depot, Denver.

St. Louis Railway Club. Sec.: E. A. Chenery, Union Station, St. Louis. Regular meetings on second Friday of each month, except July and August.

Society of Chemical Industry, New York Section. Sec.: H. Schweitzer, 40 Stone St. Meetings on third Friday after the first Monday of each month, at Chemists' Club, 108 W. 55th St.

Southern and Southwestern Railway Club. Sec.: W. A. Love, Atlanta, Ga. Regular meetings on third Thursday of Jan., April, Aug. and Nov., at Atlanta.

Technical Society of the Pacific Coast. Sec.: Otto von Geldern, 31 Post St., San Francisco. Regular meetings on first Friday of each month.

Texas Railway Club. Sec.: T. H. Osborne, Pine Bluff, Ark. Regular meetings on third Monday of April and September.

Western Railway Club. Sec.: Jos. W. Taylor, 667 Rookery, Chicago. Meetings on third Tuesday of each month, except June, July and August, Auditorium Hotel, Chicago.

Western Society of Engineers. Sec.: J. H. Warder, Monadnock Block, Chicago. Regular meetings on first Wednesday and extra meetings on third Wednesday of each month, except July and August.

Personal.

—Mr. Irving H. Reynolds is about to retire from the Allis-Chalmers Company, and the duties of chief engineer will be assumed by the engineers in charge of the various departments, these engineers availing themselves of the advice of Mr. Edwin Reynolds, consulting engineer of the company.

—Mr. George W. Colles, M. Am. Soc. M. E., has resigned his position as chief engineer of Marion & Marion, Montreal, and has opened an office as consulting mechanical and electrical engineer in Milwauke, Wis.

—Mr. J. M. Martin has resigned his position as district sales agent at the Philadelphia office of the Nernst Lamp Company, and Mr. A. E. Baker has been appointed as his successor.

—Mr. John Calder, who has been with the C. W. Hunt Company as its executive engineer, left on Saturday, November 14th, for Ilion, N. Y., where he will be connected with the management of the Remington Typewriter Company. Before leaving, he was treated to a pleasant surprise. A few minutes before the noon hour, members and employees of the company gathered around his desk to participate in the presentation of a handsome silver loving cup suitably inscribed. Mr. George S. Humphrey presented the token to him, with a few appropriate remarks, expressing the esteem in which he was held both professionally and personally by the donors. Mr. Calder made a brief impromptu reply, expressing his thanks for the gift and his regret at severing the pleasant associations he had formed while in the employ of the C. W. Hunt Company. While this company loses an efficient officer, the Remington Typewriter Company is to be congratulated on the acquisition of a man of Mr. Calder's ability and standing.

—Mr. Robert O. Cumback, for several years with the C. R. R. of N. J., and now located at the Elizabethport shops on special work, has accepted the position of superintendent of the new plant of the Pedrick & Ayer Company, located at Plainfield, N. J.

—T. J. Heller, formerly New York agent for the Federal Manufacturing Co., for their steel ball department, has left that company and has taken the sales management of the ball business of the Standard Roller Bearing Co., who have recently purchased the ball business of the Grant Tool Co. Mr. Heller will make his headquarters with the Standard Roller Bearing Co., at 48th St. and Girard Ave., Philadelphia.

—Mr. F. B. Duncan has recently been appointed manager of the Akron Electrical Manufacturing Company. About two years ago, Mr. Duncan resigned his position of general superintendent, which he held for about five years, with the Northern Electrical Manufacturing Company, Madison, Wis., to accept a similar position in the Akron Company and his present promotion is an evidence of the latter company's appreciation of his services.

Industrial Notes.

—Red-clay roofing tiles have for centuries been used in England and on the continent of Europe, their durability and consequent cheapness earning for them unqualified endorsement from engineers there. Like recognition is sure to be won here from engineers who use them. In the entire catalogue of roofing material there is nothing to equal them in the essential qualities of a roof; they are fire-proof, lasting, cool and speedily laid. Their adoption would prove a lasting testimony to the foresight of an engineer designing warehouses, piers, sheds, stations, or any of the structures appertaining to railroad systems. To take the place of skylights, which are generally sources of constant repair and expense, and to provide light wherever desired in the roof, of any sized surface, Henry Maurer & Son, of New York, have introduced heavy tough glass tiles of the identical shape and size of the red-clay tiles, and consequently interchangeable; so that even after a roof is completed, and it should become necessary to provide further light through any part thereof, the red-clay tiles can be removed and the glass ones inserted in their place at the slight cost of the labor of taking out and replacing. Henry Maurer & Son are using these glass tiles in the different buildings of their plant and can fully confirm their adaptability to the purposes indicated, and in the roofs of the buildings of the Barber Asphalt Paving Co., shown elsewhere in this issue, several have been inserted and give great satisfaction. The design of both the red-clay and the glass tiles is so practical and simple that almost any one can erect them; they overlap and lock, their own weight holding them in position. Or, if further security is desired, the tiles are formed on the bottom to admit of their being fastened to the purlins of the roof with copper wire.

—The Willamette Iron & Steel Works, of Portland, Oregon, have recently taken contracts for two 2,000-horse-power electric lighting steam engines for the Portland General Electric Co., one complete fireboat, with a capacity of 6,000 gallons per minute, for the city of Portland, and the boilers and machinery for a large tugboat for the Gray's Harbor Tugboat Co. The Willamette Iron & Steel Works have also brought out lately a new type of logging engine for yarding logs, which has received a great deal of favorable comment and is a very satisfactory machine.

—The American Sewage Disposal Company, of Boston, has published an interesting pamphlet on "Sewer Building and Sewage Disposal by the American System."

by John N. McClintock, A.M., C.E., its president and general manager. This book gives a history of the discoveries and inventions of the late Amasa S. Glover, and describes and illustrates the application of his system of sewage disposal in various places. Sewage disposal in general is discussed, and there are accounts of a number of successful plants. Another pamphlet, by the same author, is issued by the American Water Purification Company, also of Boston, and is devoted to "Water and its Purification by the American System," which system it describes and illustrates.

—The steam power plant of the St. Louis Exposition, now being built by Messrs. Westinghouse, Church, Kerr & Co., will be fitted with two large central condensing units, each consisting of a 40-inch elevated condenser capable of handling 96,000 pounds of steam per hour. These condensers are being built by Henry R. Worthington, of New York City, who will supply centrifugal pumps for handling the circulating water. That company will also furnish the rotative dry vacuum pumps which will remove all air from the condenser system. The boiler-feed pumps of this immense power plant are likewise of Worthington make.

—The Under-Feed Stoker Co. of America, at Chicago, are publishing a monthly paper, called "The Publicity Magazine," which contains illustrations and descriptions of the Jones under-feed mechanical stokers, and of various plants where they are installed, interesting and entertaining items from various sources, and general news and information.

—Arthur Koppel, the manufacturer of narrow gauge railway materials, has issued an attractive booklet, containing a great variety of useful information in convenient form, calendars for 1904, 1905 and 1906, and blank pages for memoranda.

—President Duntley, of the Chicago Pneumatic Tool Company, in referring to the affairs of his company, says that it has paid promptly all its interest and sinking fund charges on its bonded indebtedness. It has declared its dividends out of actual earnings, after writing off all expenses, fixed charges, and allowing liberally for depreciation of plants, etc. It has paid its dividends out of its own moneys. It does not owe a dollar of borrowed money. It has no floating indebtedness, except current monthly bills for material and supplies, which do not exceed $48,000, and these it is ready to pay promptly when due. The company has over $1,000,000, in quick assets over and above all current liabilities, including current bills, accrued interest, dividends, etc. Its net earnings for the past nine months are $513,224. Its present business and the outlook for the future are satisfactory in every way. Its European business is growing faster in proportion than the local business. The company is now selling its tools and machines in every civilized country in the world, and is no longer dependent on the American trade for its business. These are facts, and the company's record shows the payment of every obligation, no borrowed money, no current indebtedness, except its monthly bills, and a large surplus in quick assets. The regular annual statements will be made and published at the end of the year.

—A freight station has been established at Ampere, N. J., by the Delaware, Lackawanna & Western Railroad Company. All goods for the Crocker-Wheeler Company, should be addressed therefore to Ampere, N. J., Per D. L. & W. R. R. A daily through car service has been established between Ampere and Pier 41, North River, New York, foot of Le Roy street. All goods for the Crocker-Wheeler Company from New York City and points east should, therefore, be delivered at the Lackawanna terminal, Pier 41, North River, New York. The receipt of freight closes at this point at 4:30 P. M., and the goods will arrive at Ampere the next morning. The receipt of freight at Ampere closes at 5 P. M., and the goods will arrive at Pier 41, North River, the next morning.

—The Lunkenheimer Company, of Cincinnati, the well-known manufacturers of superior brass and iron steam specialties and engineering appliances, have opened a branch office in Paris, at No. 24 Boulevard Voltaire, where they carry a complete stock of their goods.

—The success of the new medium-speed Corliss engine recently brought out by the Ball Engine Co., of Erie, Pa., has been so great that is was found necessary to greatly increase the capacity of this company's plant. Entirely new works were determined upon and an ideal location was selected These works have been under construction during the past year, and the company has just moved into them. Although this was a large undertaking, it was accomplished without accident or any appreciable interruption of product. The new works are the most modern in the country, well lighted, and finely equipped, so giving the Ball Engine Co. unequalled facilities and a very large capacity.

—William W. Nugent & Co., of Chicago, the manufacturers of oiling and lubricating devices, receive many letters from their customers, of which the following, written by Mr. Thomas Baker, of Hilliards, O., is an example: "I write this to thank you for your valuable book on 'How to Oil an Engine,' which I received O. K. I can say that I am using in the plant where I am assistant engineer one of your patent, pendulum, dust-proof, crank-pin center oilers and it is the finest and best oiler that I have ever used. It is attached to a 500-horse-power Vilter-Corliss engine and it gives perfect satisfaction."

—Work is fast nearing completion upon the new power plant of the B. F. Sturtevant Co., at Hyde Park, Mass. This bids fair to be one of the most complete plants of its kind in the country, special care having been taken in connection with every detail to secure the highest efficiency and the most modern equipment. The plant will comprise four water-tube boilers, with stokers supplied by Sturtevant forced draft, an economizer with Sturtevant induced draft, and a complete outfit of Sturtevant generating sets, together with condenser, air compressor, etc. The Sturtevant exhaust head is used for separating the water and oil from the exhaust steam.

—The Stanley Electric Mfg. Co., of Pittsfield, Mass., have sold a 2,000-kilowatt revolving field generator to the Memphis Consolidated Gas & Electric Co., Memphis, Tenn.

—The steamship "Manchuria," of the Pacific Mail Steamship Company, was recently launched by the New York Shipbuilding Company. at Camden, N. J. The "Manchuria" has a length of 615 feet 8 inches, a breadth of 65 feet, and a depth of 51 feet, 3 inches. Its displacement is 26,514 tons, its gross tonnage, 13,500, and its indicated horse power, 12,000, and it will have a speed of 16 knots. Its passenger capacity will be 350 first cabin, 68 second cabin and 1,300 steerage.

—Wm. B. Scaife & Sons Company, of Pittsburg, manufacturers of the Scaife and We-Fu-Go systems for softening and purifying water, have appointed Mr. C. A Malau, of the City of Mexico, their sole representative in that republic for the sale of their various systems of water purification. The Scaife Company are now manufacturing every type of water purifying system, either intermittent or continuous and for treating the water either hot or cold. Their extensive experience in this line eminently fits them for carrying out any kind of water purification which they undertake. They are now softening and purifying 350,000,000 gallons of water daily for steam boilers and other industries where pure soft water is desirable, with their various systems. Mr Malau is especially well fitted to look after his clients in Mexico, as he is thoroughly acquainted with the engineering and industrial wants of that country, and has devoted considerable attention to the subject of water purification.

—Mr. F. Newton Heany has recently brought out a field book for engineers, which possesses some novel and convenient features. To facilitate field sketching, there has been placed on the right-hand pages, in addition to the usual ruling, a protractor, or circle, graduated to 5 degrees, and ruled in thin, red lines. There is also a vertical red line through the center of the circle and running the length of the page. The book is bound so as to open flat, and will be found a very handy one for field work. It is published by Wm. G. Johnston & Co, 396-398 Broadway, New York.

—The Westinghouse steam turbine is rapidly increasing its field of usefulness. The Eaton Cole & Burnham Company, of Bridgeport, Conn., are preparing plans for a turbine plant which will furnish power to their works. Large extensions to the present works are now under way and the entire plant will then be operated by polyphase motors from the new power station. A 400-kilowatt Westinghouse turbine unit will be immediately installed to provide additional power during the construction work. It will be temporarily installed in the present power house and will operate under 200 pounds steam pressure and 28 inches vacuum, without superheat. The unit will furnish three-phase current at 440 volts. The installation is in charge of Mr. Geo. Hooper, engineer, of 11 Broadway, New York.

—The water supply of the City of Washington is shortly to be improved by the construction of a large filtration plant, work on which is now in progress under the supervision of Lieut. Col. A. M. Miller, Corps of Engineers, U. S. A., and Mr. Allen Hazen, consulting engineer. The contract for the centrifugal pumps and the engines has been awarded to the Worthington Company of New York, who will supply three 36-inch pumps of the triple-vane impeller type, each direct connected to a Harrisburg, four-valve, tandem-compound, condensing engine. Each unit will be capable of supplying 30,000 gallons of water per minute at a total head of 35 feet. The Government specifications require an exceptionally high efficiency in the pumping equipment and every part of the plant will represent the latest and best practice. The company supplying the centrifugal pumps will also furnish the wash-water pumps, which will be of the direct-acting, compound, condensing type.

—The West Side Young Mens' Christian Association, whose headquarters are at 318 West 57th St., New York, offers a number of courses of instruction in drawing, mathematics, languages, music and many other subjects, which are given in the evening, under the direction of highly competent teachers. Further information regarding these opportunities may be gained by sending a 2-cent stamp for the 64-page illustrated annual catalogue of the West Side Y. M. C. A., or by calling at the building and inspecting the plant.

—The Insurance Engineering Experiment Station, of which Edward Atkinson, of 31 Milk St., Boston, is director, and which is under the supervision of the Board of Directors of the Boston Manufacturers Mutual Fire Insurance Co., has issued a report by Prof. Charles L. Norton, who is in charge of the Experiment Station, on the "Fire and Heat Resistance of the American Luxfer Prism Company's Electro-Glazed Prism and Plate Glass." The report describes and illustrates the tests which were made in the kiln of the Experiment Station, and which gave results that are very favorable to the glass of the Luxfer Prism Company.

—The Crocker-Wheeler Company, of Ampere, N. J., has recently received a number of notable orders, and these, being fairly evenly distributed among its larger branch offices, indicate that the improving condition of business is not local to any one section. One order, from the Lorain Steel Company, Lorain, O., received through the Pittsburg office, called for 41 motors, ranging in size from 2½ to 360 H. P., and representing a total of 1,423 H. P. Another large order came from the New Jersey Zinc Company, of Hazard, Pa., through the New York office, for one 125- and two 600-K. W. generators, and 37 motors aggregating 401 H. P. The Philadelphia office placed an order from the Warren Foundry & Machine Company, of Phillipsburg, N. J., for one 200-K. W. generator, four 35-H. P. and two 60-H. P. motors, and, through the Chicago office, the G. H. Hammond Company ordered for its packing plant at the Union Stock yards in that city, one 50-, one 25- and two 20-H. P. motors, and an 800-K. W., 550-volt, size 896, engine-type generator. This last is a duplicate of one now building for the St. Louis Exposition, the entire intramural plant for which will be operated by generators supplied by the Crocker-Wheeler Company.

—The Thos. H. Dallett Co., of Philadelphia, report that the outlook for business has never been more encouraging than at the present time. They are receiving a larger number of inquiries than ever before, from all parts of the country and abroad, for their portable electric and rope-driven drills, pneumatic hammers, hand drills, stone-surfacing machines, carving tools, plug drills, etc., and they have booked many large orders from well-known firms here and in Europe, among whom are the U. S. Metal & Wrecking Co., New York; Milne & Chalmers, Quincy, Mass.; Manning, Maxwell & Moore, New York; Robert Wood, Philadelphia; Henry A. Hitner Sons, Philadelphia; Allentown Boiler Works, Allentown, Pa.; Sangamon Coal Co., Springfield, Ill.; Cutter, Wood & Stephens Co., Boston, Mass.; Schuchardt & Schütte, Berlin and Vienna; Niles-Bement-Pond Co., New York

NEW CATALOGUES AND TRADE PUBLICATIONS

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Air Compressors.

Catalogue No. 33 B, with descriptions and illustrations of straight-line, half-duplex, duplex and compound high-duty air compressors, driven by steam, electricity, Pelton and turbine water wheels, gas and oil engines, for all kinds of service. 9 by 6 in.; pp. 112. Ingersoll-Sergeant Drill Co., New York.

Automobiles.

Bulletin No. 10, illustrating and describing electric storage battery tractors, designed to meet the requirements for the haulage of material in and around large shops and plants, without tracks. 11½ by 8 in.; pp. 4. Also, Bulletin No. 11, devoted to electric storage battery trucks. Gibbs Engineering & Manufacturing Co., 555 East 116th St., New York.

Bending Machines.

Booklet, with illustrations, descriptions and prices of eye benders, angle benders and other hand bending tools, samples of the work which they perform, and list of users. 6½ by 3½ in.; pp. 14. Estep & Dolan, Sandwich, Ill.

Box-Car Loaders.

Catalogue, with full and detailed illustrations and descriptions of box-car loaders, operated by steam engine or electric motor, for loading any size of bituminous or anthracite coal, ore or other minerals into box or stock cars, and testimonials from users. 9 by 7 in.; pp. 57. Christy Box-Car Loader Co., Des Moines, Iowa.

Circuit Breakers.

Mailing card, devoted to I-T-E circuit breakers for affording automatic and instantaneous protection to electric motors and generators against excessive currents. 6 by 4 in. The Cutter Co., 19th and Hamilton Sts., Philadelphia.

Condensers.

Bulletin No. 1, with an illustrated description of the latest style of saturing-air surface condenser, constructed on the Pennell system of atmospheric condensation. 10 by 6 in.; pp. 4. Arthur Pennell, 300 Heist Building, Kansas City, Mo.

Cranes.

Pamphlet, with illustrated description of full-circle revolving locomotive cranes and derricks, built for any capacity and for standard, narrow and broad gauge. 5 by 8 in.; pp. 7. Frank B. Stratford, 95-97 Liberty St., New York.

Crushers.

Folder, with illustrations of Sturtevant steel roll jaw crushers for fine work, steel sectional crushers and other styles of roll jaw crushers. 9 by 6 in.; pp. 4. Sturtevant Mill Co., Boston.

Electric Lamps.

Catalogue No. 1, with a cover of unique design, and containing descriptions and half-tone illustrations of "Star" incandescent electric lamps in many standard and special styles, their manufacture and operation. 9 by 6 in.; pp. 43. Standard Electrical Manufacturing Co., Niles, Ohio.

Electric Machines.

Bulletin No. 146, with illustrated descriptions of several types of dynamos and electric motors, including compact generating sets, portable motors for testing purposes, motors with vertical shafts and other styles, and illustrations of their application to driving machinery and to other uses. Also, Bulletin No. 147, with list of some of the users and some of the principal installations of C & C generators and motors. 10 by 7½ in.; pp. 16. C & C Electric Company, 143 Liberty St., New York.

Graphite Lubricants.

Pamphlet with illustrated descriptions and price list of Dixon's graphite lubricants for automobile and cycle chains, piano actions, yacht bottoms and a great variety of other uses, graphite greases and compounds, and a list of Dixon's graphite productions. 7½ by 5 in.; pp. 20. Joseph Dixon Crucible Co., Jersey City, N. J.

Heavy Machinery.

Booklet, with announcement of facilities for the building of heavy machinery of all kinds, including machinery for sugar works, cement plants, rolling mills, mines, smelters, etc. 6¼ by 3½ in.; pp. 3. Quincy Engine Works, Quincy, Ill.

Hydraulic Mining.

Catalogue No. 5, fourth edition, with illustrations and descriptions of the Evans hydraulic gravel elevators, riffles, gold-saving tables, undercurrents, hydraulic giants for directing a stream of water, water lifts, pipe connections and other kinds of hydraulic mining machinery, together with useful tables and data. 10 by 7 in.; pp. 48. Risdon Iron Works, San Francisco.

Logging Engine.

Circular, with illustrated description of the "Willamette Crackajack," a big drum engine for yarding logs. 8½ by 5½ in. Willamette Iron & Steel Works, Portland, Oregon.

Machine Tools.

Booklet, with illustrations and descriptions of modern high standard lathes, planes, shapers, upright drills, radial drills and boring mills for rapid work production. 3½ by 6 in.; pp. 16. American Tool Works Co., Cinc

Mechanical Draft.

Sectional catalogue No. 118, second edition, devoted to the "A B C" system of mechanical draft, forced and induced by blowers and exhaust fans, with descriptions and illustrations of the various kinds of apparatus employed, and useful tables and data. 8¾ by 7¼ in.; pp. 60. Also, catalogue No. 145, devoted to the heating and ventilation of manufacturing establishments. 9 by 7 in.; pp. 32. And catalogue No. 155, with illustrations and descriptions of steel-plate fans. 8¾ by 7¼ in.; pp. 74. American Blower Co., Detroit.

Cloth-bound catalogue of Buffalo mechanical-draft apparatus, showing applications of induced and forced mechanical draft in street railway and electric light central stations, steamship plants and industrial works, with illustrations and descriptions of suitable fan types. 7½ by 9 in.; pp. 123. Buffalo Forge Co., Buffalo.

Paint.

Index catalogue and price list, with descriptions of Mogul preservative paints, compounds and varnishes, a long list of the ways in which they can be profitably employed, and illustrations of some of the uses to which they have been put. 5½ by 4½ in.; pp. 64. A. Grothwell, 26 Montgomery St., San Francisco.

Pneumatic Tools.

Circular No. 10, with illustrations and descriptions of piston air drills, air motor hoists, pneumatic wood-boring machine, chipping and riveting air hammers, air hose, air compressors, and other pneumatic tools and appliances. 12 by 9 in.; pp. 12. Rand Drill Co., 128 Broadway, New York.

Presses.

Bulletin No. 1, with detailed descriptions and illustrations of the inclinable, open-back power presses for general manufacturing purposes, and of pendulum foot presses. 9 by 6 in.; pp. 12. Consolidated Press and Tool Co., Chicago.

Pumps.

Catalogue No. 31, with descriptions and half-tone illustrations of feed pumps, fuel-oil pumps, fire pumps, oil-line pumps, air pumps and condensers, mining pumps, sinking pumps, hydraulic pumps, and other kinds of standard and special steam pumps. 9 by 6 in.; pp. 144. A. S. Cameron Steam Pump Works, New York.

Railway Signals.

Catalogue and price list, No. 5, with illustrated descriptions of highway crossing signals of various types, and all their parts and accessories; electric block signals, both semaphore and disc; highway crossing gates; and other kinds of railway signal apparatus and supplies. 9 by 6 in.; pp. 40. The Railroad Supply Co., Chicago and New York.

Steam Goods.

Cloth-bound pocket catalogue, with illustrations, descriptions and prices of standard pressure valves and cocks, in brass and iron, fittings for steam, gas and water, extreme high pressure and hydraulic pressure valves and fittings, drainage fittings, steam and gas fitters' tools, engineers' and engine builders' supplies, hose goods, wrought pipe, and other kinds of steam, water and gas specialties. 7 by 4¼ in.; pp. 464. Crane Co., Chicago.

Steam Specialties.

Catalogue No. 9, with clear illustrations and detailed descriptions of "Emergency" steam traps, "Victor" low-pressure steam traps, improved safety water columns with automatic alarm, "Cyclone" exhaust heads, and other up-to-date steam specialties. 9 by 6 in.; pp. 32. Wright Manufacturing Co., Detroit.

Storage Batteries.

The "Exide Battery" Instruction Book, containing comprehensive directions for the operation and care of this storage battery in electric vehicles, with descriptions and illustrations of the battery and its parts. 8½ by 5 in.; pp. 31. The Electric Storage Battery Co., Philadelphia.

Track.

Large, cloth-bound catalogue No. 10, with descriptions, half-tone illustrations and line cuts of frogs, switches, crossings, derailing switches and a great variety of other kinds of rail and special track work for street railways and steam railroads. 8¾ by 11 in.; pp. 180. Wm. Wharton, Jr., & Co., Incorporated, Philadelphia.

Unloader.

Catalogue, with description of the Rapid Unloader for discharging dirt, ballast, ore, etc., from flat cars and throwing track in railroad work, and of the Leveler for handling earth in railroad construction, together with many half-tone illustrations of these machines in operation. 6 by 9 in.; pp. 48. The Lidgerwood Mfg. Co., New York.

Valves.

Catalogue and price list, with illustrated descriptions of iron and bronze gate valves, special hose valves and Siamese connections, gate valves and indicator devices for automatic sprinkler systems, globe, angle, radiator and corner valves, hydrants, extension valve boxes and floor stands, and other types of valves and their details. 5 by 9 in.; pp. 128. The Kennedy Valve Manufacturing Co., 57 Beekman St., New York.

Well Machinery.

Circular, form 88, containing sample pages from a larger catalogue, with illustrations and descriptions of Chapman's air-lift pumping system, air compressors, steam and gasoline pumping engines, working barrels for wells, artesian well screens, vertical centrifugal pumps, drilling tools, and other deep-well pumping appliances. 9 by 6 in.; pp. 32. American Well Works, Aurora, Ill.

Wood-Working Machinery.

Catalogue pages, with illustrations and description of a fast-feed flooring machine, with improved belt-feed, made in three sizes, to plane 10, 12 and 15 inches wide by 6 inches thick. 10½ by 7½ in.; pp. 4. H. B. Smith Machine Co., Smithville, N. J.

NEWS SUPPLEMENT

The Engineering Magazine—January, 1904

Coming Society Meetings.

American Assocation for the Advancement of Science. Sec.: Prof. L. O. Howard, Cosmos Club, Washington, D. C. Annual meeting, Dec. 28-Jan. 2, at St. Louis.

American Economic Association. Sec.: F. A Fetter, Ithaca, N. Y. Annual meeting, Dec. 29 to Jan 1, at New Orleans.

American Institute of Electrical Engineers. Sec.: Ralph W. Pope, 95 Liberty St., New York. Next meeting, Jan. 29. Papers on Alternating Current Railway Motors.

American Institute, Polytechnic Section. Sec.: George Whitefield, Jr., 19 W. 44th St., New York. Meetings on first and third Thursdays of each month, from October to May, inclusive.

American Railway Association. Sec.: W. F. Allen, 24 Park Place, New York. Next meeting, April 27, at New York.

American Railway Engineering and Maintenance of Way Association. Sec.: L. C. Fritch, Monadnock Block, Chicago. Annual meeting, March 15-17, at Chicago.

American Railway Master Mechanics' Association. Sec.: J. W. Taylor, 667 Rookery, Chicago. Meeting, June 27-29, Saratoga Springs, N. Y.

American Society of Civil Engineers. Sec.: C. W. Hunt, 220 W. 57th St., New York. Regular meetings, first and third Wednesdays of each month, except July and August. Annual meeting, Jan. 20.

American Society of Heating and Ventilating Engineers. Sec.: W. M. Mackay, 12 W. 31st St., New York. Annual meeting, Jan. 19-21, at New York.

American Society of Mechanical Engineers. Sec.: Prof. F. R. Hutton, 12 W. 31st St., New York. Next meeting in May, at Chicago.

Architectural League of America. Sec.: J. B. Nettleton. Next meeting, April or May, at Pittsburg.

Boston Society of Civil Engineers. Sec.: S. E. Tinkham, 715 Tremont Temple. Regular meetings on fourth Wednesday in January and on third Wednesday of other months, except July and August.

Brooklyn Engineers' Club. Sec.: J. Strachan, 191 Montague St. Regular meetings on second Thursdays of each month.

Canadian Railway Club. Sec.: W. H. Rosevear, Jr., Montreal. Regular meetings on first Tuesday of each month.

Canadian Society of Civil Engineers. Sec.: Prof. C. H. McLeod, 877 Dorchester St., Montreal. The General Section and the Electrical, Mechanical and Mining Sections meet on different Thursdays.

Central Railway Club. Sec.: Harry D. Vought, 62 Liberty St., New York. Regular meetings on second Fridays of Jan., March, May, Sept. and Nov., Hotel Iroquois, Buffalo.

Chicago Electrical Association. Sec.: W. B. Hale, Monadnock Building. Regular meetings on first and third Fridays of each month, from October to May.

Civil Engineers' Club of Cleveland. Sec.: Joseph C. Beardsley, 689 The Arcade. Regular meetings on second and fourth Tuesdays of each month.

Civil Engineers' Society of St. Paul. Sec.: G. S. Edmondstone. Regular meetings on second Monday of each month.

Engineering Association of the South. Sec.: Robt. L. Lund, 2102 Hayes St., Nashville, Tenn. Regular meetings on second Thursday of each month at the Berry Block.

Engineers' Club of Chicago. Sec.: B. W. Thurtell, 1223 New York Life Building. Regular meetings on first and third Tuesdays of each month.

Engineers' Club of Cincinnati. Sec.: J. F. Wilson, P. O. Box 333. Regular meeting on third Tuesday of each month.

Engineers' Club of Columbus (Ohio). Sec.: H. M. Gates, 12½ North High St. Regular meetings on first and third Saturdays of each month.

Engineers' Club of Minneapolis. Sec.: Jas. B. Gilman, American Bridge Co. Regular meetings on third Monday of each month.

Engineers' Club of Philadelphia. Sec.: J. O. Clarke, 1122 Girard St. Regular meetings on first and third Saturdays of each month, except July and August.

Engineers' Club of St. Louis. Sec.: H. J. Pfeifer, 920 Rialto Bldg. Regular meetings on first and third Wednesdays.

Engineers' Society of Western New York. Sec.: H. B. Alverson, 533 Ellicott Square, Buffalo. Regular meetings on first Tuesday of each month.

Engineers' Society of Western Pennsylvania. Sec.: Chas. W. Ridinger, 410 Penn Ave., Pittsburg. Regular meetings on third Tuesday of each month.

Franklin Institute. Sec.: Dr. Wm. H Wahl, 15 South 7th St., Philadelphia. General meetings on third Wednesday of each month, except July and August. General section meetings every Thursday.

Honolulu Engineering Association. Sec.: G. F. Bush, Hololulu, Hawaii.

Illinois Society of Engineers and Surveyors. Sec.: E. E. R. Tratman, Monadnock Block, Chicago. Annual meeting, Jan. 20-22, at Champaign.

INDIANA ENGINEERING SOCIETY. Sec.: C. C. Brown, Indianapolis. Annual meeting, Jan. 14-16, at Indianapolis.

IOWA RAILWAY CLUB. Sec.: P. B. Vermillion, Des Moines, Iowa. Regular meetings on third Tuesday of each month.

LOUISIANA ENGINEERING SOCIETY. Sec.: G. W. Lawes, 806 Gravier St., New Orleans. Regular meetings on second Monday of each month.

MASTER CAR BUILDERS' ASSOCIATION. Sec.: J. W. Taylor, 667 Rookery, Chicago. Meeting, June 22-24, Saratoga Springs.

MICHIGAN ENGINEERING SOCIETY. Sec.: F. Hodgman, Climax, Mich. Annual meeting, Jan. 12-14, at Lansing.

MONTANA SOCIETY OF ENGINEERS. Sec.: Clinton H. Moore, Butte, Mont. Regular meetings on second Saturday in each month.

NATIONAL ELECTRIC LIGHT ASSOCIATION. Sec.: Ernest H. Davis, 136 Liberty St., New York. Annual convention in May, at Boston.

NEW ENGLAND RAILROAD CLUB. Sec.: Edw. L. Janes, Back Bay P. O., Boston. Regular meetings, second Tuesday in each month, at Pierce Hall, Copley Square.

NEW YORK ELECTRICAL SOCIETY. Sec.: Geo. H. Guy, 114 Liberty St., New York. Meetings monthly, on different Wednesdays, at the American Institute, 19 W. 44th St.

NEW YORK RAILROAD CLUB. Sec.: F. M. Whyte, Grand Central Station, N. Y. City. Regular meetings on third Friday of each month, except June, July and August, at Carnegie Hall, 154 W. 57th St., New York.

NEW YORK STREET RAILWAY ASSOCIATION. Sec.: W. W. Cole, Elmira. Annual meeting, Sept., at Utica.

NORTHWESTERN ELECTRICAL ASSOCIATION. Sec.: Thos. R. Mercein, Milwaukee. Annual convention, Jan. 20, at Milwaukee.

NORTH-WEST RAILWAY CLUB. Sec.: T. W. Flannagan, Minneapolis, Minn. Regular meetings on first Tuesday after second Monday of each month, except June, July and August, alternating between Minneapolis and St. Paul.

PACIFIC COAST ELECTRICAL TRANSMISSION ASSOCIATION. Sec.: Geo. P. Low, 237 Cherry St., San Francisco. Annual convention, third Tuesday in June. Intermediate meetings subject to call.

PACIFIC COAST RAILWAY CLUB. Sec.: C. C. Borton, West Oakland, Cal. Regular meetings on third Saturday of each month at San Francisco and other cities.

PACIFIC NORTHWEST SOCIETY OF ENGINEERS. Sec.: G. F. Cotterill, Seattle, Wash. Meetings monthly in Chamber of Commerce rooms, Seattle.

RAILWAY CLUB OF PITTSBURG. Sec.: J. D. Conway, P. & L. E. R. R., Pittsburg Pa. Regular meetings on fourth Friday of each month, at Hotel Henry.

RAILWAY SIGNAL ASSOCIATION. Sec.: B. B. Adams, 83 Fulton St., New York. Regular meetings on second Tuesday of January, March, May, Sept. and Nov.

RICHMOND RAILROAD CLUB. Sec.: F. O. Robinson, 8th & Main Sts., Richmond, Va. Regular meetings on second Thursday of each month, except June, July and August.

ROCKY MOUNTAIN RAILWAY CLUB. Sec.: M. M. Currier, Colorado City. Regular meetings on first Saturday after the 15th of each month, at Union Depot, Denver.

ST. LOUIS RAILWAY CLUB. Sec.: E. A. Chenery, Union Station, St. Louis. Regular meetings on second Friday of each month, except July and August.

SOCIETY OF CHEMICAL INDUSTRY, NEW YORK SECTION. Sec.: H. Schweitzer, 40 Stone St. Meetings on third Friday after the first Monday of each month, at Chemists' Club, 108 W. 55th St.

SOUTHERN AND SOUTHWESTERN RAILWAY CLUB. Sec.: W. A. Love, Atlanta, Ga. Regular meetings on third Thursday of Jan., April, Aug. and Nov., at Atlanta.

TECHNICAL SOCIETY OF THE PACIFIC COAST. Sec.: Otto von Geldern, 31 Post St., San Francisco. Regular meetings on first Friday of each month.

TEXAS RAILWAY CLUB. Sec.: T. H. Osborne, Pine Bluff, Ark. Regular meetings on third Monday of April and September.

WESTERN RAILWAY CLUB. Sec.: Jos. W. Taylor, 667 Rookery, Chicago. Meetings on third Tuesday of each month, except June, July and August, Auditorium Hotel, Chicago.

WESTERN SOCIETY OF ENGINEERS. Sec.: J. H. Warder, Monadnock Block, Chicago. Regular meetings on first Wednesday and extra meetings on third Wednesday of each month, except July and August.

Personal.

—Mr. H. F. J. Porter, who has been associated with Westinghouse interests since the first of the year and has held the position of Assistant Manager of the Publishing Department, with offices in East Pittsburg and 10 Bridge Street, New York, has been made Second Vice-President of the Nernst Lamp Company, of which enterprise Mr. George Westinghouse is President, with the duties of General Manager and with headquarters at Pittsburg. He assumed charge on December 1st. This appointment does not affect Mr. Porter's relations with the Publishing Department at the present time.

—Mr. Walter H. Whiteside, the Manager of the Detail and Supply Department of the Westinghouse Electric & Manufacturing Company, has also been made the General

Manager of the Sawyer-Man Electric Company, and has added the duties of this new office to his former ones. Few men are better known than Mr. Whiteside in the electrical business. He has been connected with electrical trade interests for nearly twenty years, and during that time has extended his acquaintanceship to every part of the country and cemented friendships wherever he went.

—Mr. Frank T. Craven has resigned his position with the C. J. Field Conduit Company to represent the American Conduit Company, of 170 Broadway, New York, Chicago and California.

Industrial Notes.

—The American Society of Mechanical Engineers held one of the sessions of its annual December meeting at Hoboken, N. J., in the new auditorium of Stevens Institute of Technology. There was a peculiar appropriateness in this, as the first formal meeting of the Society was held at Stevens Institute, in 1880, and, probably, in the room which occupied the site of the new auditorium. This fine hall, which was finished just before the latest visit of the Mechanical Engineers, will comfortably accommodate about 700 persons, on the main floor and in the gallery. There is a good-sized and well arranged stage, with space in front for an orchestra, the acoustic properties of the hall are very satisfactory, and its decorations are in excellent taste. The Mechanical Engineers opened the auditorium with one of their regular morning sessions, at which papers were read and discussed, and afterwards they were escorted through all the departments of Stevens Institute by student guides. Luncheon was served in the Carnegie Laboratory of Engineering, and in the afternoon the members of the Society and their friends re-assembled in the auditorium, where Dr. Hans Goldschmidt, of Essen, Germany, lectured on "Alumino-Thermics," or the production of high temperatures by burning aluminum. and their applications to engineering and metallurgy, illustrating his address with many striking experiments.

—The "Circolo Enofile Italiano," a society of wine growers and distillers, of Rome, announce on the occasion of their annual exhibition, an international competition of apparatus utilizing alcohol, such as motors, automobiles, motor cycles, lamps, heating apparatus, etc. This exhibition and competition will take place in Rome, from February 6 to February 16, 1904. Every facility will be offered to intending exhibitors and competitors, and gold, silver and bronze medals will be given to the winners in the various classes.

—The Pennsylvania Railroad Company will design and cause to be constructed a suitable plant for testing locomotives, and, in co-operation with the Department of Transportation Exhibits, will install this plant at St. Louis. The plant will be ready for preliminary running by the first of March next, and in perfect running condition by the first of May, at which time formal work will commence. The purpose of the whole work is to be comprehensive and the endeavor will be to determine by the use of locomotives presenting different characteristics, the effect of the latter upon the economic performance, and the limits of the tractive power and boiler capacities. The Pennsylvania Railroad System will organize and maintain, under the direction of its Engineer of Tests, a staff of laboratory attendants and computors, to the end that the plant and the locomotives thereon may be safely and properly operated and the experimental data promptly handled. It will also provide supplies of fuel and oil and will meet all other fixed charges incident to the progress of the work. The Pennsylvania Railroad System, having called to its aid an Advisory Committee to assist in all matters of scientific interest, will in consultation with this Committee make selection of locomotives to be tested, determine conditions under which tests are to be run, specify as to the observations to be taken and the methods to be employed, and determine the manner in which the data shall be handled and the form in which the final results shall be presented. Further information may be obtained from F. D. Casanave, special agent of the Pennsylvania Railroad System, 910 Penn Square Building, Philadelphia.

—The Electric Club, of Pittsburg, announces that it will issue an illustrated monthly magazine to be styled *The Electric Club Journal.* The first number will appear February 1, 1904. The immediate purpose is to put into permanent form the engineering papers and technical discussions that form a regular part of the work of The Electric Club. Many of the papers will be written by the engineering staff of a leading electric company, and much of the material will pertain to the latest apparatus and to the newest problems in engineering work. This matter will be published in a form suited to the needs of intelligent young men. The circulation of *The Electric Club Journal* is not restricted to the members of the Club, but the privilege of subscribing is extended to others.

—The Brown Corliss Engine Co., of Corliss, Wis., are manufacturing a full line of sawmill machinery, and have opened a special department for this class of machinery in the Wells Building, Milwaukee, in charge of Theo. S. Wilkin. They are also about to complete a contract with a foreign corporation to handle a full line of blast-furnace gas-engines. These lines will be carried on in connection with their Corliss-engine and rolling-mill work.

—The Reeves Engine Company are installing two of their vertical cross compounds in the new plant of the Megargee Paper Company at Modena, Pa. The larger is a 650-H. P. engine, designed for direct connection to the main shaft of the mill, and on this account the closest regulation is required. The smaller engine is to operate the electric plant.

—The New York Continental Jewell Filtration Co. have recently sold pressure and gravity filters to the following: F. J. F. Lovejoy, Pittsburg; Fleischmann & Co., New York; White Swan Laundry, Wheeling, W. Va.; City of Winston, N. C.; Salem Water Supply Co., Winston-Salem, N. C.; Springfield Gas Light Co., Springfield, Mass.; L. L. Brown Paper Co., Adams, Mass.

—In no branch of government service has the matter of ventilation been given such serious consideration as in the navy. The construction of the modern vessel renders it extremely difficult to secure proper ventilation in some portions below the water line. Noticeable for its novelty, among the various methods used to properly ventilate such places is the portable ventilating set, consisting of a small exhauster of the Monogram type directly connected to an enclosed electric motor. It is very light, moves a large body of air, and is provided with handles for carrying from place to place, thus enabling the crew to work in any portion of the vessel with comfort. It is but one of the many types of blowers manufactured by the B. F. Sturtevant Co., of Boston, Mass.

—The American Steam Gauge & Valve Mfg. Co. have again been compelled to seek new quarters, owing to the increase of their business, and are at present removing their entire plant and offices from Bismarck Street, Roxbury District, to the large brick buildings, 208-220 Camden Street, Boston, Mass. The buildings have floor space of 85,000 square feet. The Mowry & Phillips foundry department will also be removed from South Boston, and every branch of the business consolidated at the Camden Street factory. The new plant will afford the American Steam Gauge & Valve Mfg. Co. more than double the present capacity, and will be employed in producing their valves, gauges and indicators, and also special metals and foundry work in the Mowry & Phillips department.

—The Indicator Contest held by the Eagle Oil & Supply Co., 104 Broad Street, Boston, Mass., closed December 12th. It was participated in by hundreds of engineers from all over the country, and great interest was taken. Mr. J. P. Kennah, 13 Holden Street, Dorchester, Mass., was the lucky engineer, and will enjoy the pleasure of using one of the finest Robertson-Thompson indicators.

—The Erie Railroad Company has issued a convenient pocket map covering some of the western part of New York and Pennsylvania and the eastern part of Ohio, a district rich in coal, oil, natural gas and water power, and to which comes the iron ore from Lake Superior, so that it is a commanding territory for the manufacture of iron and steel, and a fine location for other industrial establishments. The Erie Railroad covers this region with its main line and many branches, and full information to manufacturers and others will be furnished by its industrial commissioner, Luis Jackson, 21 Cortlandt Street, New York.

—The Vulcan Iron Works Co., of Toledo, Ohio, the manufacturers of elevator, bucket and dipper dredges, excavators, boiler fronts, etc., state that the reports that they had shut down, owing to lack of orders, are untrue in every particular. On the contrary, they have 150 or more men in steady employment and are getting more than the usual number of inquiries at this season for steam shovels and dredges, and their prospects for the spring trade are bright.

—The Wright Manufacturing Company, of Detroit, recently opened a New York office and salesroom at 159 Centre Street, corner of Walker Street, with Mr. James H. Pearson in charge. A complete line of the Wright Company's steam specialties will be carried in stock, including the "Wright" and the "Victor" improved safety water columns, "Emergency" high-pressure steam traps, "Victor" low-pressure steam traps, "Cyclone" exhaust heads, etc. This company report a greater demand than ever before for their goods, but they are able to keep abreast of orders, as their shop facilities were considerably enlarged a few months ago.

—The Helmick Foundry-Machine Co., of Fairmont, W. Va., the manufacturers of coal and coke plant equipments, mine cars, castings, etc., announce the completion of their new foundry and smith shop, which they have enlarged and improved, so that they are now better prepared than ever before to take care of their large and growing trade.

—The Watt Mining Car Wheel Co., of Barnesville, Ohio, have established a Chicago office, in the Old Colony Building, under the management of Mr. Ira E. Stevens, in order to more efficiently handle their business for the States of Indiana, Illinois, Iowa, Michigan, Minnesota, Missouri, North and South Dakota, and Wisconsin.

—The Federal Manufacturing Company, Diamond Chain Factory, of Indianapolis, state that the form of guarantee adopted by American manufacturers of chains for bicycles, motor cycles and automobiles is as follows: "We will replace such chains as in our judgment show defects in workmanship or material, provided same are returned to us for inspection, transportation charges prepaid. We agree to prepay return transportation charges to consignor on all replacements. On account of the various conditions under which chains are used and cared for, we cannot guarantee the certain performance of any chain, and will not replace chains or parts which have been used. Customers should inspect chains as soon as received, and report any supposed defects or complaints before returning same."

—The Otis Elevator Company will install in the twenty-five story building of the International Banking Corporation, 60 Wall Street, eight hydraulic passenger elevators and two electric freight elevators.

—A. Leschen and Sons Rope Co., whose home office is 920-932 North First Street, St. Louis, and who have branch offices in New York, Chicago and Denver, have the legend, "We pull for Leschens," on the large leather collars of the horses attached to the wagons in which they deliver their reels and coils of Hercules and Patent Flattened Strand and all other kinds of wire rope. A. Leschen & Sons Rope Co. also manufacture and erect aerial wire rope tramways of every description; likewise underground and surface wire-rope haulage plants. Their engineers in charge of the different departments have had years of experience and are thoroughly competent.

—The Crocker-Wheeler Company, of Ampere, N. J., has established headquarters for the Southern representative of its Washington Office, Mr. S. M. Conant, at 425 Empire Building, Atlanta, Ga.

—An extensive pump-manufacturing plant, the largest in this country, and probably in the world, is now under construction at Harrison, N. J. It is to be occupied by the firm of Henry R. Worthington, who employ about 3,000 men in their present works at South Brooklyn, L. I., and Elizabethport, N. J. The new plant at Harrison will accommodate from 4,000 to 5,000 men and will cost in the neighborhood of two million dollars. It consists of a main machine shop with side galleries over 1,006 feet long, an erecting shop 592 feet long and of the same section as the machine shop, and a high erecting shop, 210 feet in length and four galleries in height in the side bays connecting the two shops. The main foundry is 600 feet in length and there is also a special foundry for small work, 410 feet in length, with a building 200 by 60 feet in size for cleaning castings connecting the two. The pattern building is four stories high and 550 feet long and is divided by wire walls into four sections.

The north section will be used for offices and drafting rooms, the adjoining section for the pattern shop, and the balance of the structure for pattern storage. The power house, which will be equipped with the most modern boilers, engines and generators, is a building 172 by 102 feet. Electric power distribution is to be employed throughout, and the grounds will be illuminated by electric arc lights. There are many other buildings which will be used for packing, storing and shipping goods, etc. The buildings are so arranged that additions can be built when the work demands it. All will be connected by a complete system of railroad tracks entering the ends of the buildings and placing the works in direct communication with the Delaware, Lackawanna & Western, the Erie and the Pennsylvania Railroad Systems. The new plant will be devoted entirely to the manufacture of water-works machinery, water meters, cooling towers, condensers, feed-water heaters, centrifugal pumps and steam pumps of all kinds.

—The Association of Portland Cement Manufacturers recently held its second annual meeting in New York, where much business of importance was successfully transacted. Reports were received from committees appointed to confer with other societies in the matters of standard tests and specifications for cement and for concrete-steel construction, and uniform contracts between manufacturers and dealers and manufacturers and consumers. A resolution was adopted that the members of the Association should close their mills for six weeks or more, between December 1 and April 1, in order that necessary repairs may be made, many of the mills having been in continuous operation for the last two years. The Association will erect a fine building at the St. Louis Exposition. Robert W. Lesley, of the American Co., retired from the office of president and was succeeded by J. B. Loher, of the Vulcanite Co.; A. F. Gerstell, of the Alpha Co., formerly secretary, was elected vice-president; E. M. Young, of the Lehigh Co., formerly treasurer, was elected secretary, and E. R. Ackerman, of the Lawrence Co., becomes treasurer. The new executive committee consists of H. W. Maxwell, W. H. Harding, R. W. Lesley, W. R. Warren, George E. Bartol, E. N. Hagger and S. B. Newberry. A banquet was given by the Association at Sherry's, at which a silver loving cup was presented to R. W. Lesley, the retiring president.

—Westinghouse gas engines are to be adopted in a new central station now under erection at Berlin, Ontario. The initial installation will aggregate 460 horse power, comprising three 13 by 14-inch, three-cylinder, 125 horse-power, and one 11 by 12-inch, three-cylinder, 85 horse-power vertical engines. These engines will operate on city illuminating gas of 650 B. T. U. calorific value, and drive direct-current generators for furnishing municipal lighting.

The high potential transformer built by the electrical engineering department of the Worcester Polytechnic Institute, in 1898, under the direction of Professor Harold B. Smith, the head of the department, has recently been sold to Mr. C. S. Knowles of Boston, and has been sent by him to New Lexington, Ohio, for installation at that place. It will be used in connection with the High Voltage Porcelain Works in which Mr. Knowles is interested. The transformer has already been installed and is now ready for testing work. The installation was performed by Messrs. J. A. Sandford and W. T. Goddard, assistants to Professor Smith in the electrical engineering department of the Institute.

—The electrolysis-proof, bituminized-fibre, electric conduit, which the American Conduit Company introduced in California a few years ago, is now in general use there, is extensively employed in the Middle States, and is making fine progress in the East. It is used by the United States Government in the navy yards on the Atlantic and Pacific, in the War Department, in the fortifications at New London, Conn., and in the Congressional Library at Washington, D. C.; by the Chicago Telephone Company; by the Atchison, Topeka and Santa Fe Railroad; by the University of Chicago; by the Western Union Telegraph Company; by the Pennsylvania Railroad Company, and by many others. The American Conduit Company has its offices at 170 Broadway, New York; 822 Manhattan Building, Chicago, and 336 Macy St., Los Angeles, and its factories at Philadelphia, Chicago and Los Angeles, California.

NEW CATALOGUES AND TRADE PUBLICATIONS

These catalogues may be had free of charge on application to the firms issuing them.
Please mention The Engineering Magazine When you write.

Air Compressors.

Bulletin No. L 509, with illustrations and descriptions of a new line of air compressors of the duplex, duplex two-stage and cross-compound two-stage types, built with massive "rolling-mill" frames and fitted with the Meyer steam-valve gears, which permit of an adjustable cut-off. 9 by 6 in.; pp. 9. The Laidlaw-Dunn-Gordon Co., 116 Liberty St., New York.

Automobiles.

White Bulletin No. 2, devoted principally to accounts, with map and illustrations, of the automobile endurance run from New York to Pittsburg, nearly 800 miles, in which the White steam touring cars made a remarkably fine showing. 9¾ by 6¾ in.; pp. 16. White Sewing Machine Co., Cleveland.

Circuit Breakers.

Bulletin "C," with illustrations and descriptions of various types of the Hartman oil circuit breaker and switch, including one for electric cars, which automatically breaks an electric circuit when an overload occurs, and possesses many points of advantage. 5¾ by 4 in.; pp. 12. The Creaghead Engineering Co., Cincinnati.

Conveying Machinery.

Pamphlet No. 037, containing an introduction to the general line of machinery manufactured by the C. W. Hunt Co., including coal-hoisting towers and elevators, steam shovels, coal tubs, overhead trolleys, automatic railways, cable railways, steam and electric hoisting engines, "Stevedore" rope, coal conveyors, coal screens and valves, narrow-gauge industrial railways, electric locomotives, and other kinds of apparatus and machinery. 6 by 3½ in.; pp. 20. C. W. Hunt Company, West New Brighton, N. Y.

Cranes.

Catalogue No. 18, with illustrations of electric and hand-power traveling cranes especially designed for service in pumping stations, power stations for electric railways and large industrial plants, and lighting stations. 6 by 9 in.; pp. 16. Northern Engineering Works, Detroit.

Cylinder Oil.

Miniature book, devoted to the Eagleine special 700° cylinder oil, which has been tested by experience and is a most successful lubricant. 2½ by 2½ in.; pp. 16. Eagle Oil and Supply Co., Boston.

Dynamos.

Instruction Book No. 104, containing illustrated directions for the installation and care of direct-connected, engine-type, direct-current electric generators, with wiring diagrams. 6 by 3½ in.; pp. 26. Sprague Electric Company, 527-531 West 34th St., New York.

Electric Driving.

Catalogue No. 26, devoted to shop and tool equipments with Northern electric motors, containing handsomely illustrated descriptions of the motors, and accounts of their application to the driving of all kinds of machinery, including several reprints of articles in magazines and reports and discussions of engineering societies. 10 by 7 in.; pp. 101. Also, bulletin No. 34, illustrating and describing Northern motors operating Coffin sluice and gate valves, and booklets and leaflets devoted to various applications of these motors. Northern Electrical Manufacturing Co., Madison, Wis.

Electric Lamps.

Folder No. S. M. 4014, a booklet of suggestions for those who use incandescent lamps, containing illustrations and descriptions of Sawyer-Man incandescent electric lamps in many styles and for a great variety of purposes. 6 by 3½ in.; pp. 28. Sawyer-Man Electric Co., 510 West 23d St., New York.

Electric Lighting.

Circular, illustrating and describing an outfit for Christmas tree lighting and other decorative purposes, consisting of miniature incandescent electric lamps and of miniature sockets and lamp cord connected together and made up for immediate use. 7½ by 5¼ in.; pp. 4. General Electric Company, Harrison, N. J.

Electric Meters.

Publication No. 3197, with flexible-cloth binding, containing general data on Thomson recording wattmeters, including illustrated descriptions, connection and wiring diagrams, instructions for installation, maintenance and use, and index. 6¾ by 4¼ in.; pp. 217. General Electric Co., Schenectady, N. Y.

Engines.

Catalogue No. 62, containing a partial list of foreign users of Corliss engines, pumping engines, hoisting engines, compressors and blowing engines built by the Allis-Chalmers Company, with illustrations of some of the prominent types of these engines, which are in use in all parts of the world. 4¼ by 6 in.; pp. 78. Allis-Chalmers Company, Chicago.

Forced Draft.

Booklets, devoted, respectively, to mechanical forced draft and steel pressure blowers, with illustrations and descriptions of steel plate fans, "B" volume fans and engines, and other forced-draft and blowing apparatus. 6½ by 3½ in.; pp. 24. Also, booklet with illustrated description of the Buffalo Underwriter fire pump and the Buffalo duplex boiler feed pump. 6 by 3½ in.; pp. 4. Buffalo Forge Company, Buffalo.

Induction Motors.

Circular No. 1066, containing a description, illustrated by half tones and diagrams, of constant speed induction motors and their parts. 10 by 7 in.; pp. 12. Westinghouse Electric & Mfg. Co., Pittsburg.

Modernizing Engineers.

Bulletin No. 144, a report on Dodge & Day "betterment reports" on shop conditions, which deal with the numerous factors that, together, make up the complete manufacturing plant. This bulletin explains the Dodge & Day methods of investigating and reporting on manufacturing establishments, and contains illustrations, diagrams and descriptions which show the wide range of the work this firm has already done. 9 by 6 in.; pp. 23. Dodge & Day, Nicetown, Philadelphia.

Pile Drivers.

Bulletin No. 6, with well illustrated descriptions of a railroad pile driver, its car body, trucks, slewing frame, machinery equipment and other parts, and views showing the pile driver in its various positions. 6 by 9 in.; pp. 20. Kaltenbach & Griess, Engineers, Cleveland.

Pneumatic Tools.

Catalogue, Form No. 4, with finely illustrated descriptions of "axial-valve" pneumatic chipping and riveting hammers, duplex pneumatic "holder-on," oil rivet forge, reciprocating piston drills, and other Haeseler pneumatic tools and appliances. 9 by 6 in.; pp. 32. The Ingersoll-Sergeant Drill Co., 26 Cortlandt St., New York.

Portable Drills.

Pamphlet, with illustrations and descriptions of portable drills, adapted to a great variety of work in machine shops and other places, and operated by the Stow flexible shaft, which is driven by electric motors, pneumatic motors and in other ways. 9 by 6 in.; pp. 8. Stow Flexible Shaft Co., Frederic Schoff, Prop'r, Philadelphia.

Pumps.

"Pump Data" No. 5, a bulletin with illustrations and description of the Aldrich variable-speed triplex pump, fitted with direct-current electric motors, which are coupled to one shaft and connected to the pump through single-reduction gears. 9 by 6 in.; pp. 8. The Allentown Rolling Mills, Allentown, Pa.

Railway Materials.

Supplement to catalogue No. 77, containing additional information about the Koppel switches and turnouts and other narrow-gauge track materials, several new types of cars for special purposes, and tubs for handling material, with many illustrations. 10 by 8 in.; pp. 11. Arthur Koppel, 66-68 Broad St., New York.

Roller Bearings.

Bulletin No. 20, with fully illustrated descriptions of the Hyatt flexible roller bearing and its application to shop trucks, foundry cars and wagons, cranes, hoisting machinery, conveying machinery, glass machinery, lumber cars, transfer cars and tables, and other uses involving heavy duty at slow speed. 8¼ by 6½ in.; pp. 63. Hyatt Roller Bearing Co., Harrison, N. J.

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NEWS SUPPLEMENT

The Engineering Magazine—February, 1904

Coming Society Meetings.

American Institute of Electrical Engineers. Sec.: Ralph W. Pope, 95 Liberty St., New York. Next meeting, Feb. 26, at Chemists' Club, 108 W. 55th St. Papers on Power Transmission. Annual dinner, Feb. 11, at Waldorf-Astoria.

American Institute, Polytechnic Section. Sec.: George Whitefield, Jr., 19 W. 44th St., New York. Meetings on first and third Thursdays of each month, from October to May, inclusive.

American Railway Association. Sec.: W. F. Allen, 24 Park Place, New York. Next meeting, April 27, at New York.

American Railway Engineering and Maintenance of Way Association. Sec.: L. C. Fritch, Monadnock Block, Chicago. Annual meeting, March 15-17, at Chicago.

American Railway Master Mechanics' Association. Sec.: J. W. Taylor, 667 Rookery, Chicago. Meeting, June 27-29, Saratoga Springs, N. Y.

American Society of Civil Engineers. Sec.: C. W. Hunt, 220 W. 57th St., New York. Regular meetings, first and third Wednesdays of each month, except July and August.

American Society of Mechanical Engineers. Sec.: Prof. F. R. Hutton, 12 W. 31st St., New York. Next meeting in May, at Chicago.

Architectural League of America. Sec.: J. B. Nettleton. Next meeting, April or May, at Pittsburg.

Boston Society of Civil Engineers. Sec.: S. E. Tinkham, 715 Tremont Temple. Regular meetings on third Wednesday of each month, except July and August.

Brooklyn Engineers' Club. Sec.: J. Strachan, 191 Montague St. Regular meetings on second Thursday of each month.

Canadian Railway Club. Sec.: W. H. Roseyear, Jr., Montreal. Regular meetings on first Tuesday of each month, except June, July and August.

Canadian Society of Civil Engineers. Sec.: Prof. C. H. McLeod, 877 Dorchester St., Montreal. The General Section and the Electrical, Mechanical and Mining Sections meet on different Thursdays.

Central Railway Club. Sec.: Harry D. Vought, 62 Liberty St., New York. Regular meetings on second Friday of January, March, May, September, and November, Hotel Iroquois, Buffalo.

Chicago Electrical Association. Sec.: W. B. Hale, Monadnock Building. Regular meetings on first and third Fridays of each month, from October to May.

Civil Engineers' Club of Cleveland. Sec.: Joseph C. Beardsley, 689 The Arcade. Regular meetings on second and fourth Tuesdays of each month.

Civil Engineers' Society of St. Paul. Sec.: G. S. Edmondstone. Regular meetings on second Monday of each month.

Connecticut Society of Civil Engineers. Sec.: J. F. Jackson, New Haven. Annual meeting, Feb. 9 and 10, at Hartford.

Engineering Association of the South. Sec.: Robt. L. Lund, 2102 Hayes St., Nashville, Tenn. Regular meetings on second Thursday of each month at the Berry Block.

Engineers' Club of Chicago. Sec.: B. W. Thurtell, 1223 New York Life Building. Regular meetings on first and third Tuesdays of each month.

Engineers' Club of Cincinnati. Sec.: J. F. Wilson, P. O. Box 333. Regular meeting on third Thursday of each month, except July and August.

Engineers' Club of Columbus (Ohio). Sec.: H. M. Gates, 12½ North High St. Regular meetings on first and third Saturdays of each month.

Engineers' Club of Minneapolis. Sec.: Jas. B. Gilman, American Bridge Co. Regular meetings on third Monday of each month.

Engineers' Club of Philadelphia. Sec.: J. O. Clarke, 1122 Girard St. Regular meetings on first and third Saturdays of each month, except July and August.

Engineers' Club of St. Louis. Sec.: H. J. Pfeifer, 920 Rialto Bldg. Regular meetings on first and third Wednesdays of each month.

Engineers' Society of Western New York. Sec.: H. B. Alverson, 533 Ellicott Square, Buffalo. Regular meetings on first Tuesday of each month, except July and August.

Engineers' Society of Western Pennsylvania. Sec.: Chas. W. Ridinger, 410 Penn. Ave., Pittsburg. Regular meetings on third Tuesday of each month.

Franklin Institute. Sec.: Dr. Wm. H. Wahl, 15 South 7th St., Philadelphia. General meetings on third Wednesday of each month, except July and August. General section meetings every Thursday.

Honolulu Engineering Association. Sec.: G. F. Bush, Honolulu, Hawaii.

Iowa Railway Club. Sec.: P. B. Vermillion, Des Moines, Iowa. Regular meetings on third Tuesday of each month.

Louisiana Engineering Society. Sec.: G. W. Lawes, 806 Gravier St., New Orleans. Regular meetings on second Monday of each month.

Master Car Builders' Association. Sec.: J. W. Taylor, 667 Rookery, Chicago. Meeting, June 22-24, Saratoga Springs.

Montana Society of Engineers. Sec.: Clinton H. Moore, Butte, Mont. Regular meetings on second Saturdays.

National Electric Light Association. Sec.: Ernest H. Davis, 136 Liberty St., New York. Annual convention in May, at Boston.

New England Railroad Club. Sec.: Edw. L. Janes, Back Bay P. O., Boston. Regular meetings, second Tuesday in each month, except June, July, August and September, at Pierce Hall, Copley Square.

New York Electrical Society. Sec.: Geo. H. Guy, 114 Liberty St., New York. Meetings monthly, on different Wednesdays, at the American Institute, 19 W. 44th St.

New York Railroad Club. Sec.: F. M. Whyte, Grand Central Station, N. Y. City. Regular meetings on third Friday of each month, except June, July and August, at Carnegie Hall, 154 W. 57th St., New York.

New York Street Railway Association. Sec.: W. W. Cole, Elmira. Annual meeting, Sept., at Utica.

North-West Railway Club. Sec.: T. W. Flannigan, Minneapolis, Minn. Regular meetings on first Tuesday after second Monday of each month, except June, July and August, alternating between Minneapolis and St. Paul.

Pacific Coast Electrical Transmission Association. Sec.: Geo. P. Low, 237 Cherry St., San Francisco. Annual convention, third Tuesday in June. Intermediate meetings subject to call.

Pacific Coast Railway Club. Sec.: C. C. Borton, Oakland, Cal. Regular meetings on third Saturday of each month at San Francisco and other cities.

Pacific Northwest Society of Engineers. Sec.: Prof. M. Roberts, Seattle, Wash. Meetings monthly in Chamber of Commerce rooms, Seattle.

Railway Club of Pittsburg. Sec.: J. D. Conway, P. & L. E. R. R., Pittsburg, Pa. Regular meetings on fourth Friday of each month, except June, July and August, at Hotel Henry.

Railway Signal Association. Sec.: B. B. Adams, 83 Fulton St., New York. Regular meetings on second Tuesday of January, March, May, Sept. and Nov.

Richmond Railroad Club. Sec.: F. O. Robinson, 8th & Main Sts., Richmond, Va. Regular meetings on second Thursday of each month, except June, July and August.

Rocky Mountain Railway Club. Sec.: M. M. Currier, Colorado City. Regular meetings on first Saturday after the 15th of each month, at Union Depot, Denver.

St. Louis Railway Club. Sec.: E. A. Chenery, Union Station, St. Louis. Regular meetings on second Friday of each month, except July and August.

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O., as consulting engineer, and is in charge of the department devoted to the building of large high-duty crank and fly-wheel pumps.

—Mr. Arthur J. Herschmann, M. E., has opened an office at 45 Broadway, New York, as a consulting engineer. He will make a specialty of heating, lighting and ventilating plants, their installation and supervision, and will be glad to be consulted by persons desirous of effecting improvement or economies in such plants. He will also represent the Commercial Automobile Company, Incorporated, which concern is to work the American patents on the Herschmann system of steam trucks.

—Mr. N. S. Braden, formerly manager of the Westinghouse Electric & Manufacturing Company's district office at Cleveland, has been appointed sales manager of the new Canadian Westinghouse Company, Ltd., and assumed the duties of that office on January 1, 1904. Mr. Braden succeeds the late Thomas C. Frenyear, who died on December 10th of last year. Mr. Frenyear's office was at Toronto, but Mr. Braden will make his headquarters at Hamilton, Ontario.

—Mr. H. M. Deavitt, analytical and consulting chemist and assayer, with a large practice in Chicago, has taken the management of the Chicago office of the Engineering Co., of America, 159 LaSalle St., with which office Mr. Ellis C. Spoker, the expert in cement plants, has also become associated. Mr. Edward Everett, civil engineer, who has specialized in railroad work, and who made the survey for one of the Hudson River tunnels, has become connected with the Engineering Co. of America's New York office, 74 Broadway.

—Mr. W. S. Montgomery, who has for the past five years been connected with the Conover Condenser Manufacturing Company, of Jersey City, as their secretary and sales manager, severed his connection with that company on January 1, 1904, to assume the management of the Payne Engineering Company, of New York City, which are the selling agents of the Payne Company, of Elmira, N. Y., builders of simple and compound automatic engines. On the same date the Payne Engineering Company removed to new offices in the Havemeyer Building, No. 26 Cortlandt St.

Industrial Notes.

—The Loomis-Pettibone Gas Machinery Company, after the recent increase in capital, has now been merged with The Holthoff Machinery Co., of Milwaukee, Wis., under the new corporate name of Power and Mining Machinery Company, with head offices at 52 and 54 William St., New York. The combined companies are making extensive improvements and additions to their Milwaukee plant to meet the increasing demand for the American Crossley gas engines, Loomis-Pettibone gas apparatus, and Holthoff mining machinery.

—The Lunkenheimer Company, of Cincinnati, the makers of superior brass and iron steam specialties, owing to the unprecedented and growing demand for their products, have again greatly increased their facilities, and are now in position to guarantee reasonably prompt shipments. Their foreign branches report an increasing export demand for their goods, and they will shortly place some new specialties upon the market which will be contained in a very complete catalogue to be issued in the course of a few months.

—The Pneumatic Tool Department of the Ingersoll-Sergeant Drill Co., of 26 Cortlandt St., New York, has just issued a calendar of novel and artistic design: It pictures a workman operating a Haeseler pneumatic hammer on a skyscraper, while a colored reproduction of an "axial" valve, which is a very important feature of the Haeseler-Ingersoll hammer, rotates on its axis at the middle of the calendar and points to the days of the month which are shown below.

—Warren Brothers Company, the makers of the bitulithic pavement, have been awarded the contract for the paving of West 72nd Street, New York, which is a fine boulevard connecting Central Park and Riverside Drive. The Park Department made a wise choice in selecting bitulithic pavement, which is very durable and at the same time affords as good a foothold as macadam.

—The General Electric Company, through its Incandescent Lamp Sales Department, at Harrison, N. J., has issued a handsome wall circular for use in ordering lamps. This circular contains full-size illustrations of the company's standard incandescent lamps and of many of its special lamps, among the latter being turn-down night lamps, reflector lamps, round-bulb lamps, stereopticon lamps, resistance lamps, candelabra and sign lamps, examination lamps for storage batteries, and other styles.

—Messrs. Woolston and Brew, mechanical engineers, have established salesrooms and a storage depôt for automobiles at 152 West 56th St., New York, where they will care for vehicles and keep them in repair. They have also secured the agencies for the Thomas triple-vertical-cylinder, 24-horsepower, gasoline touring car and the Stevens-Duryea gasoline runabout.

—The stockholders of The Otto Gas Engine Works, of Philadelphia, have decided to increase the capital of the corporation from $600,000 to $2,500,000, and build a large, new plant just as soon as the management can find a site suitable for the purpose. Large gas engines, producer gas plants, launches and marine engines, gasoline hoists, compressors and other adaptations of the gas engine, will be built promptly at the new plant. A suitable site must contain not less than thirty acres, must be located on a good water front and must have good railroad facilities.

—The 100th anniversary of the exploration of the Oregon country by Captains Meriwether Lewis and William Clark, of the United States Army, will be celebrated by an international exposition, to be held at Portland, Oregon, in 1905.

—Owing to a confusion of names, some people have been under the impression that the Berlin Construction Company, of Berlin, Conn., is going out of business. This is most emphatically not the case, as the above-mentioned company, which during the past three years, has taken and completed contracts for bridges, buildings and structural steel work amounting to millions of dollars, is rapidly increasing its business and is in most active operation.

—An important export order has just been closed with the Manila Construction Company, an American corporation conducting operations in the city of Manila, P. I., for a complete power equipment for the city traction system. The order was secured through Westinghouse, Church, Kerr & Company, and comprises the following machinery: 3 750-kilowatt Westinghouse turbo-generator units; 2 compound engine exciter units; 1 motor-driven exciter unit; 3 500-kilowatt rotary converters; 1 30 kilowatt rotary converter; 4 250-kil 1 300-kilowatt rotary converters; 4 250-kil watt oil-insulated transformers; a comple switchboard; 1 series booster, mounted the extended shaft of one of the rotary co verters. The car equipments will compri ninety double No. 68 C outfits, and t double No. 56 outfits, using standard Wes inghouse controllers.

—One of the features of the new plant the B. F. Sturtevant Co., at Hyde Par Mass., peculiarly indicative of the perma ent character of the new works now und construction, is the steam tunnel 4½ feet width, and 6½ feet high, extending fro the power plant to the most remote part the manufacturing buildings, a total distanc of about 800 feet. This tunnel, which is concrete construction, will not only accommodate all of the steam piping, but also th electric wires for power, light, telephon standard time clock, and other service, together with oil, hot water and other pipe for general distribution to the various buildings of the plant. None of these features the equipment will be carried above groun at any outdoor point. While the expens of such an installation is necessarily larg the convenience of access for changes an repairs will in the future much more tha offset any fixed charges thereon.

—A material for preventing loss by fir and danger to life from the short-circuitin of high voltage electrical wires, for whic the trade mark "Niagrite" has been adopte is being placed on the market by the H. W Johns-Manville Co. "Niagrite" is furnished in strips of several widths from 3 inche to 26 inches and is held in place by asbesto fire-proof glue, thus protecting the cable from external fire and confining the internal fire. The material presents a ver neat and permanent finish, and is not affected by atmospheric conditions. It has bee adopted by the Niagara Falls Power Co The Buffalo Street Railroad Co., the International Power Co., The Edison (Ne York) Co., and other prominent and important electrical plants. Full informatio can be obtained from the Asbestos Department of the H. W. Johns-Manville Co., 10 William St., New York.

—The Ross Valve Co., of Troy, N. Y., are sending their friends an attractive and convenient desk calendar, consisting of a leather case which holds cards for the different months.

—The Eagle Oil and Supply Co., of Boston, have issued a calendar which contains some handsome pictures, reproduced from photographs and paintings, and which they will send to any address upon receipt of 10 cents in stamps.

—The Foundrymen's Associations of the country are arranging to have a special building at the St. Louis World's Fair, which will serve as a headquarters for foundrymen and as a place for exhibiting every class of modern foundry equipment and product. Parts of the exhibit will be operating in a way to show the public something of the methods of foundry work. Further particulars may be obtained by addressing Philadelphia Foundrymen's Association, Howard Evans, Secretary, Pier 45 North, Philadelphia, or J. A. Holmes, Chief of Mines and Metallurgy, World's Fair, St. Louis.

—The Builders' Iron Foundry and the Diamond Machine Co., of Providence, R. I., are distributing a very convenient little souvenir which combines a screw driver, an opener for light boxes and an inch scale, divided into sixteenths, attached to a key ring.

—The Ashcroft Manufacturing Co., the Consolidated Safety Valve Co., the Hancock Inspirator Co., and the Hayden & Derby Mfg. Co., have established branch offices and salesrooms at 22, 24 and 26 South Canal St., Chicago, where they will carry a full and complete line of their goods, thus enabling them to fill orders from their Western customers with promptness. These offices will be in charge of Messrs. H. S. Whitney and M. A. Hudson.

—The Buhl Malleable Co., of Detroit, the successors of the Detroit Sprocket Chain Co., will be pleased to submit estimates and furnish blue prints and specifications for the installation of elevating, conveying and power-transmitting machinery, and to quote figures for malleable and grey-iron castings and metal or wood pattern work.

—The Brown Corliss Engine Co., of Corliss, Wis., have received an order from the Passaic Steel Co., of Paterson, N. J., for a 24-inch and 48-inch by 36-inch tandem rolling-mill engine.

—The Power Installation Company, of Buffalo, of which Mr. Geo. F. Wescott is vice-president and general manager, have issued a limited edition de luxe of a book entitled "Power Problems," which shows the improvements in the several systems of power transmission, as illustrated by many plants embracing boilers, engines, dynamos, conveyors, stokers, grinding and briquetting machinery, electric motors and other appliances, which they have designed and installed.

—The West Side Branch of the Young Men's Christian Association, at 318 West 57th St., New York, is having a series of lectures given by experts on structural engineering and architecture. Admission to these lectures is by tickets, which may be had free upon application. At the evening school of the West Side Y. M. C. A. instruction is given in a long list of subjects, ranging from mathematics to music, further information about which may be had by applying at the building, or by writing to the educational director.

—A friend of Lafayette College has bought and presented to the Henry W. Oliver Chemical and Metallurgical Library of that institution all the pamphlets, about 3,000 in number, belonging to the library of the late Professor Johannes Wislicenus, of the University of Leipsic. Professor Wislicenus was a famous chemist. He was a pioneer in the study of the lactic acids and led in the work which gave to us our present knowledge of stereoisomerism. This library represents the collection of fifty years of great activity and will be a fine addition to the Oliver Library and Lafayette College.

—The lifting of a thousand-ton steel bridge to a height of twenty inches so that it will clear its old supports, its transfer upstream a distance of thirty-five feet and its final lowering to a new pivot pier ten and a half feet lower than that on which it originally rested is an engineering feat of more than ordinary importance. And when it is accomplished in a space of twelve hours, with unfavorable tides, winds and river currents, it becomes all the more remarkable. Yet this is what was performed by Chief Engineer Bush of the Lackawanna Railroad recently in transferring a new steel double-deck draw span from old to new piers across the Passaic River, at Newark, New Jersey. The bridge in question is 220 feet long, arranged for two sets of tracks one above the other. The track elevation and track depression work which the Lackawanna Railroad is doing in territory suburban to New York City involved the movement of this bridge so that the tracks on the lower deck would be at grade with the new freight tracks, and the tracks on the upper deck with the new passenger tracks. It is a simple matter to move a bridge and raise and lower it through a small difference in elevation, but to drop it ten to twelve feet exactly on top of a pivot pier located in a strong tideway is a more troublesome operation. The secret of its successful accomplishment dates back to the early Egyptians, who lowered immense stones by allowing a column of fine sand upon which they rested to run out from underneath. But the difference between the sand device used by the Lackawanna engineers and that of the ancient Egyptians is too great for them to be considered similar save in name. Probably nothing like the huge sand bins used in this modern work was ever seen before. Four immense cylinders built on scows carried the sand, which in turn supported the plungers which held the bridge. A set of slides controlled the orifices through which the sand was allowed to run out, and so perfectly was the work performed that the bridge settled into place without so much as a scratch. In other words, the sand boxes and plungers were so constructed that the difference between the elevation of grade line of the bridge on the old location and the grade line of the bridge on the new location, amounting to ten and a half feet, was taken care of by letting out the sand in the cylinders. The variation in the height of the tides and the lifting of the bridge from its old location on to the scows, as well as the releasing of the scows from underneath the bridge in its new location, were controlled by means of water ballast, which was pumped in and out of the four scows by four centrifugal pumps having a capacity of 1,600 gallons per minute. The work was started at 4 A. M. and the bridge touched the new pivot pier at 5 P. M., completing a connection that renders possible the handling of the road's immense suburban traffic in a most satisfactory way. Many bridge engineers prophesied the failure of the undertaking, but its complete success justified the boldness of the plan and stamps it as the standard method of such operations in future.

—The Chilean Government has decided to construct a sewerage system for the capital city of Santiago, the cost of which will exceed $5,000,000, and has invited bids from contractors. The completion of the Trans-andine Railway, via Uspallata, is another great work of the government of Chile, for which bids must be submitted by May 1st. Further information about these great enterprises and about every branch of commercial and industrial work in Chile will be furnished by the International Agency of Industrial and Commercial Propaganda, Santiago, Chile.

Messrs. McLaughlin Brothers, whose offices are in the Land Title Building, Philadelphia, have become selling agents for the product of The Reeves Engine Co. for Southern New Jersey, Eastern Pennsylvania, Delaware, Maryland and the District of Columbia.

—An indication of the large amount of river and harbor improvement work now under way or contemplated by the United States Government is given by the fact that at present ten suction dredges are being built, two of which will be sent to the Great Lakes, two to New York Harbor, two to the Mississippi River, two to Charleston, S. C., one to Galveston, and one to Savannah, Ga. The contracts for building these vessels have been distributed to a large number of builders, possibly for the purpose of hastening their completion. Five are being constructed by the Maryland Steel Company, two by the Jas. Reilly Repair & Supply Co., and one each by the W. R. Trigg Co., the Petersburg Iron Works Co. and the New York Shipbuilding Co. The mechanical equipment of the dredges for salt-water service will include surface-condenser outfits with Blake air pumps, feed pumps, fire pumps, etc. The dredges for the Great Lakes are provided with very large Blake cross-compound, double-acting air pumps and jet condensers with the usual complement of Blake vertical duplex feed pumps, fire pumps, etc. The air pumps are of a very novel arrangement, inasmuch as it is possible to cut each pump in half and run one side entirely independent of the other.

NEW CATALOGUES AND TRADE PUBLICATIONS

These catalogues may be had free of charge on application to the firms issuing them.
Please mention The Engineering Magazine When you write.

Advertising.

Pamphlet, entitled "Publicity," giving an interesting description of courses of instruction in the principles and practice of advertising, show-card writing and window dressing, with many illustrations. 9 by 6 in.; pp. 48. International Correspondence Schools, Scranton, Pa.

Cranes.

Cloth-bound catalogue, with descriptions and many half-tone illustrations of electric and steam locomotive cranes, steam wrecking cranes, electric traveling cranes, high-speed balanced cantilever and gantry cranes, hand traveling cranes, jib cranes, floating cranes, stationary hand bridge cranes, pillar cranes, hand truck cranes, overhead tramrail and trolley, railway transfer tables and other kinds of hoisting and handling machinery. 6 by 9 in.; pp. 261. The Brown Hoisting Machinery Co., Incorporated, Cleveland, Ohio.

Drop Forgings.

Booklet, with illustrations and descriptions of drop forgings of many kinds, and, particularly, a list of drop-forged cranks and crank shafts, in various styles and sizes. 6 by 3½ in.; pp. 39. Wyman & Gordon, Worcester, Mass.

Catalogue, with illustrations and descriptions of many styles of wrenches, pliers, ratchet drills, and a great variety of other drop forgings. 7½ by 5 in.; pp. 119. Also, catalogues devoted, respectively, to drop forgings for vehicles and automobiles; drop hammers, trimming presses and heating furnaces; and commutator segments for all standard street-railway electric motors. The Billings and Spencer Co., Hartford, Conn.

Dryers.

Catalogue D, containing a well illustrated description of drying machines for clay, rock, ores, lime, sand, furnace slag and other materials to which direct heat may be applied, and accounts of other dryers for many more kinds of material, together with records of tests, testimonials and list of users. 5¾ by 8¾ in.; pp. 28. Ruggles-Coles Engineering Co., 39 Cortlandt St., New York.

Electric Brewery.

Bulletin No. 39, with illustrations and description of the interesting electrical and mechanical equipment of the Orange Brewery, where the power for many of the processes is supplied by electric motors. 10 by 7½ in.; pp. 8. Crocker-Wheeler Co., Ampere, N. J.

Electric Rock Drill.

Catalogue No. 1, with illustration and description of the Deitz electric rock drill, in which the piston is released from the driving mechanism before the rock is struck, thus protecting the working parts from any harmful shocks. The whole drill is of simple and substantial design and is made of the best materials. 8½ by 6 in.; pp. 11. The Deitz Drill and Machinery Co., Denver, Colo.

Filtration.

Pamphlet, containing a brief historical sketch of the Alexandria (Egypt) Water Works, and a report on the results of a series of successful experiments which were made there with a Jewell gravity filter plant, with illustrations, diagrams and tables. 10¾ by 8¼ in.; pp. 31. The New York Continental Jewell Filtration Co., 15 Broad St., New York.

Foundry.

Bulletin No. 54, containing a well illustrated and interesting description of the new foundry and pattern departments of the B. F. Sturtevant Co., at Hyde Park, Mass., and their modern equipment for the manufacture of fans, blowers, mechanical-draft apparatus, and other machinery and industrial appliances. 9 by 6½ in.; pp. 16. B. F. Sturtevant Co., Boston, Mass.

Friction Clutches.

Booklet C, with illustrations and description of the Johnson friction clutch, both single and double, for gas engines, countershafts and machines in general. 6½ by 3½ in.; pp. 11. Also, folders devoted to these clutches, which have but few parts and are very compact. The Carlyle Johnson Machine Co., Hartford, Conn.

Gas Producers.

Pamphlet, entitled "Gas for Furnace Work," containing an illustrated account, abstracted from the *Engineering Record*, of a model Loomis-Pettibone gas plant for supplying direct-fired furnaces for forging, for heating rivets, angles and plates, and for other uses, at the works of the Pennsylvania Steel Company, Steelton, Pa. 10 by 7 in.; pp. 8. Power and Mining Machinery Co. (formerly Loomis-Pettibone Gas Machinery Co.), 52 William St., New York.

Graphite.

A pamphlet giving a tastefully illustrated account of some of the uses to which graphite may be put. Among the subjects are: Pencils; crucibles; graphite in the foundry; lubrication for automobiles and bicycles, guns, power launches, etc.; "pot-lead" for yacht bottoms; graphite in electrotyping and other electrical work; stove polish and stove cement; belt dressing; graphite paint; and pipe-joint compound. 8½ by 4 in.; pp. 24. The Joseph Dixon Crucible Co., Jersey City, N. J.

Hack Saws.

Catalogue No. 10, containing illustrations, descriptions and prices of hack saws with flexible-back blades, flexible-back band saws, band-saw frames, jig-sawing machines for cutting steel dies, patterns, etc., non-friction band-saw guides, and other metal-sawing machinery and appliances. 9 by 6 in.; pp. 16. The Henry G. Thompson & Son Co., New Haven, Conn.

Hot-Blast Smelting.

Pamphlet entitled "The Hot-Blast Stove and Its Application to Copper and Pyritic Smelting" and containing a collection of papers on the utility and great importance of a heated air blast in smelting all kinds of ores, with many illustrations. 9½ by 6½ in.; pp. 64. The Colorado Iron Works Co., Denver.

Jacks.

Catalogue E, with illustrations, descriptions and prices of Barrett patent compound-lever and differential-screw jacks for cars and automobiles, raising track, automatic lowering, forcing pipe horizontally through the ground, wrenching and unwrenching oil-well tools, lifting and removing motor armatures, moving loads horizontally, and for other kinds of work. 8¼ by 5¾ in.; pp. 54. The Duff Manufacturing Co., Pittsburg, Pa.

Lathes.

Catalogue (Lathe No. 21), containing half-tone illustrations and comprehensive descriptions of various styles of metal-working lathes, adapted to the use of the modern high-speed steel tools, their parts and attachments, together with telegraphic code. 6 by 9 in.; pp. 68. The Bradford Machine Tool Co., Cincinnati, Ohio.

Locomotives.

Cloth-bound book, with illustrations and descriptions of light locomotives, of both broad and narrow gauges, for logging, plantation, contractors' and every other variety of industrial and special service. These locomotives will burn wood, coke or bituminous coal, and can be adapted to use petroleum as fuel. The book contains also useful tables and information about locomotives and railways. 6 by 9 in.; pp. 72. Baldwin Locomotive Works, Philadelphia, Pa.

Logging Engines.

Catalogue L-2, containing illustrations and descriptions of logging engines, including yarding engines and road engines, the Fouts grip wheel and traction engine, [illegible] engines, towing engines, friction devices, logging trucks, road and yarding spools, fairleaders, wire rope, and other kinds of logging machinery and tools. 7½ by 9¼ in.; pp. 47. Willamette Iron & Steel Works, Portland, Oregon.

Magnetic Separator.

Pamphlet describing the Cleveland-Knowles magnetic separator, which is particularly adapted for removing the iron minerals from zinc-lead ores, and the methods of treating these ores. 8½ by 5½ in.; pp. 9. Also, catalogues devoted, respectively, to mining machinery and concentrating plants and to ammonia compressors and other refrigerating machinery. United Iron Works Co., Springfield, Missouri.

Milling Machines.

Catalogue, containing descriptions and illustrations of large milling machines and milling cutters, of new design, built in accordance with he most modern ideas, for heavy work and high eds and consequent large output. 9 by 6 in.; 22. The Hess Machine Co., Pennsylvania lding, Philadelphia.

Pipe Machinery.

Catalogue No. [illegible], with flexible cloth covers, containing illustrations, descriptions and prices of improved pipe-threading and cutting-off machinery, hand and power machines, taper taps, "Peerless" adjusting machines for threading dies, and other machines and accessories, together with useful tables and information. [illegible] in.; pp. [illegible]. Bignall & Keeler Mfg. Co., Edwardsville, Ill.

Pneumatic Tubes.

Book containing elaborate illustrations and descriptions of pneumatic tube service for transporting mail, messages, merchandise, and all other things about stores and works and office buildings. 9½ by 7 in.; pp. 48. Lamson Pneumatic Service Co., Boston, Mass.

Rotary Planers.

Catalogue No. 57, with illustrations and descriptions of various styles and sizes of high-grade rotary planing machines, fixed or portable and either belt or motor driven. 9 by 6 in.; pp. 76. Newton Machine Tool Works (Incorporated), Philadelphia.

Scrapers.

Fully illustrated catalogue, with descriptions of wheeled earth scrapers, drag scrapers, elevating graders, ditchers and wagon loaders, railroad and township plows, reversible graders, dump, ore and stone cars, dump carts and wagons, and other appliances and machinery for handling earth and stone. 6¾ by 9¼ in.; pp. 44. Western Wheeled Scraper Co., Aurora, Ill.

Screens.

Catalogue No. 69, containing illustrations and descriptions of vibrating, revolving, and other styles of screens and screening plants for treating coal, coke, rock, stone, clay, ores, cinder, cement, sand and many other kinds of material. 9 by 6 in.; pp. 56. Also, catalogue No. 52, devoted to coal-washing machinery. 7 by 9 in.; pp. 76. The Jeffrey Manufacturing Co., Columbus, Ohio.

Sugar Machinery.

Catalogue, with illustrations and descriptions of all kinds of machinery for the extraction and manufacturing of sugar, and a variety of other machinery, and mill, factory, plantation, railroad and steamboat supplies. 10 by 7 in.; pp. 186. John H. Murphy's Iron Works, New Orleans, La.

Testing Machines.

Catalogue A, containing illustrations and descriptions of Riehlé testing machines for general purposes, in capacities from 500,000 pounds down, extensometers and special appliances, torsion testing machines, dynamometers, etc. 12¼ by 9½ in.; pp. 88. Also, catalogues B, C, D, E, F, G, H and I, devoted, respectively, to wire and cloth testing machines; chain testing machines; transverse testing machines; spring testing machines; hydraulic pumps, presses and other machinery; cement testing machines; marble machinery; and tools and contractors' supplies. 12 by 9 in. Riehlé Bros. Testing Machine Co., Philadelphia.

NEWS SUPPLEMENT

The Engineering Magazine—March, 1904

Coming Society Meetings.

Air-Brake Association. Sec.: F. M. Nellis, 174 Broadway, New York. Annual meeting May 10, at Buffalo.

American Electrochemical Society. Sec.; C. J. Reed, 929 Chestnut St., Philadelphia. Next meeting April 7 to 9, at Washington, D. C.

American Institute of Electrical Engineers. Sec.: Ralph W. Pope, 95 Liberty St., New York. Next meeting, March 25, at Chemists' Club, 108 W. 55th St. Papers on High-Tension Transmission.

American Institute, Polytechnic Section. Sec.: George Whitefield, Jr., 19 W. 44th St., New York. Meetings on first and third Thursdays of each month, from October to May, inclusive.

American Railway Association. Sec.: W. F. Allen, 24 Park Place, New York. Next meeting, April 27, at New York.

American Railway Engineering and Maintenance of Way Association. Sec.: L. C. Fritch, Monadnock Block, Chicago. Annual meeting, March 15-17, at Chicago.

American Railway Master Mechanics' Association. Sec.: J. W. Taylor, 667 Rookery, Chicago. Meeting, June 27-29, Saratoga Springs, N. Y.

American Society of Civil Engineers. Sec.: C. W. Hunt, 220 W. 57th St., New York. Regular meetings, first and third Wednesdays of each month.

American Society of Mechanical Engineers. Sec.: Prof. F. R. Hutton, 12 W. 31st St., New York. Next meeting, May 31 to June 4, at Chicago.

Architectural League of America. Sec.: J. B. Nettleton. Next meeting, April or May, at Pittsburg.

Boston Society of Civil Engineers. Sec.: S. E. Tinkham, 715 Tremont Temple. Regular meetings on third Wednesday of each month, except July and August.

Brooklyn Engineers' Club. Sec.: J. Strachan, 191 Montague St. Regular meetings on second Thursday of each month. March 10, paper on "The Relation between Gas Corporations and Consumers," by H. S. Wynkoop.

Canadian Mining Institute. Sec.: B. T. A. Bell, Ottawa. Annual meeting March 2 to 5, at Toronto.

Canadian Railway Club. Sec.: W. H. Rosevear, Jr., Montreal. Regular meetings on first Tuesday of each month, except June, July and August.

Canadian Society of Civil Engineers. Sec.: Prof. C. H. McLeod, 877 Dorchester St., Montreal. The General Section and the Electrical, Mechanical and Mining Sections meet on different Thursdays.

Central Railway Club. Sec.: Harry D. Vought, 62 Liberty St., New York. Regular meetings on second Friday of January, March, May, September, and November, Hotel Iroquois, Buffalo.

Chicago Electrical Association. Sec.: W. B. Hale, Monadnock Building. Regular meetings on first and third Fridays of each month, from October to May.

Civil Engineers' Club of Cleveland. Sec.: Joseph C. Beardsley, 689 The Arcade. Regular meetings on second and fourth Tuesdays of each month.

Civil Engineers' Society of St. Paul. Sec.: G. S. Edmondstone. Regular meetings on second Monday of each month.

Engineering Association of the South. Sec.: Robt. L. Lund, 2102 Hayes St., Nashville, Tenn. Regular meetings on second Thursday of each month at the Berry Block.

Engineers' Club of Chicago. Sec.: B. W. Thurtell, 1223 New York Life Building. Regular meetings on first and third Tuesdays of each month.

Engineers' Club of Cincinnati. Sec.: J. F. Wilson, P. O. Box 333. Regular meeting on third Thursday of each month, except July and August.

Engineers' Club of Columbus (Ohio). Sec.: H. M. Gates, 12½ North High St. Regular meetings on first and third Saturdays of each month.

Engineers' Club of Minneapolis. Sec.: Jas. B. Gilman, American Bridge Co. Regular meetings on third Monday of each month.

Engineers' Club of Philadelphia. Sec.: J. O. Clarke, 1122 Girard St. Regular meetings on first and third Saturdays of each month, except July and August.

Engineers' Club of St. Louis. Sec.: H. J. Pfeifer, 920 Rialto Bldg. Regular meetings on first and third Wednesdays.

Engineers' Society of Western New York. Sec.: H. B. Alverson, 533 Ellicott Square, Buffalo. Regular meetings on first Tuesday of each month.

Engineers' Society of Western Pennsylvania. Sec.: Chas. W. Ridinger, 410 Penn. Ave., Pittsburg. Regular meetings on third Tuesday of each month.

Franklin Institute. Sec.: Dr. Wm. H. Wahl, 15 South 7th St., Philadelphia. General meetings on third Wednesday of each month, except July and August. General section meetings every Thursday.

Honolulu Engineering Association. Sec.: G. F. Bush, Honolulu, Hawaii.

International Engineering Congress. Sec.: Charles Warren Hunt, 220 W. 57th St., New York. Meeting Oct. 3 to 8, at St. Louis.

Iowa Railway Club. Sec.: P. B. Vermillion, Des Moines, Iowa. Regular meetings on third Tuesday of each month.

Louisiana Engineering Society. Sec.: G. W. Lawes, 806 Gravier St., New Orleans. Regular meetings on second Monday of each month.

Master Car Builders' Association. Sec.: J. W. Taylor, 667 Rookery, Chicago. Meeting, June 22-24, Saratoga Springs.

Montana Society of Engineers. Sec.: Clinton H. Moore, Butte, Mont. Regular meetings on second Saturday in each month.

National Electric Light Association. Sec.: Ernest H. Davis, 136 Liberty St., New York. Annual convention in May, at Boston.

New England Railroad Club. Sec.: Edw. L. Janes, Back Bay P. O., Boston. Regular meetings, second Tuesday in each month, except June, July, August and September, at Pierce Hall, Copley Square.

New England Water Works Association. Sec.: Willard Kent, Tremont Temple, Boston. Next meeting, March 10, at Boston.

New York Electrical Society. Sec.: Geo. H. Guy, 114 Liberty St., New York. Meetings monthly, on different Wednesdays, at the American Institute, 19 W. 44th St.

New York Railroad Club. Sec.: F. M. Whyte, Grand Central Station, N. Y. City. Regular meetings on third Friday of each month, except June, July and August, at Carnegie Hall, 154 W. 57th St., New York.

New York Street Railway Association. Sec.: W. W. Cole, Elmira. Annual meeting, Sept., at Utica.

North-West Railway Club. Sec.: T. W. Flannagan, Minneapolis, Minn. Regular meetings on first Tuesday after second Monday of each month, except June, July and August, alternating between Minneapolis and St. Paul.

Pacific Coast Electrical Transmission Association. Sec.: Geo. P. Low, 237 Cherry St., San Francisco. Annual convention, third Tuesday in June. Intermediate meetings subject to call.

Pacific Coast Railway Club. Sec.: C. C. Borton, West Oakland, Cal. Regular meetings on third Saturday of each month at San Francisco and other cities.

Pacific Northwest Society of Engineers. Sec.: Prof. M. Roberts, Seattle, Wash. Meetings monthly in Chamber of Commerce rooms, Seattle.

Railway Club of Pittsburg. Sec.: J. D. Conway, P. & L. E. R. R., Pittsburg, Pa. Regular meetings on fourth Friday of each month, except June, July and August. Hotel Henry.

way Signal Association. Sec.: B
ms, 83 Fulton St., New York. Regu-
tings on second Tuesday of January,
May, Sept. and Nov.

Richmond Railway Club. Sec.: F. O. Robinson, 8th & Main Sts., Richmond, Va. Regular meetings on second Thursday of each month, except June, July and August.

Rocky Mountain Railway Club. Sec.: M. M. Currier, Colorado City. Regular meetings on second Tuesday of each month at Union Depot, Denver.

St. Louis Railway Club. Sec.: E. A. Chenery, Union Station, St. Louis. Regular meetings on second Friday of each month, except July and August.

Society of Chemical Industry, New York Section. Sec.: H. Schweitzer, Stone St. Meetings on third Friday after the first Monday of each month, at Chemists' Club, 108 W. 55th St.

Southern and Southwestern Railway Club. Sec.: W. A. Love, Atlanta, Ga. Regular meetings on third Thursday of Jan., April, Aug. and Nov., at Atlanta.

Technical Society of the Pacific Coast. Sec.: Otto von Geldern, 31 Post St., San Francisco. Regular meetings on first Friday of each month.

Texas Railway Club. Sec.: T. H. Osborne, Pine Bluff, Ark. Regular meetings on third Monday of April and September.

Western Railway Club. Sec.: Jos. W. Taylor, 667 Rookery, Chicago. Meetings on third Tuesday of each month, except June, July and August, Auditorium Hotel, Chicago.

Western Society of Engineers. Sec.: J. H. Warder, Monadnock Block, Chicago. Regular meetings on first Wednesday and extra meetings on third Wednesday of each month, except July and August.

Personal.

—Mr. William A. Sweet, the well-known steel maker and manufacturer, died at his home in Syracuse, N. Y., on January 30th.

—Mr. Nikola Tesla announces that in connection with the commercial introduction of his inventions, he will render professional services in the general capacity of consulting electrician and engineer. His laboratory is on Long Island, and his residence at the Waldorf-Astoria Hotel, New York.

—Mr. Putnam A. Bates, assistant secretary and sales manager of the Crocker-Wheeler Company, has resigned that position, and has formed a partnership with Mr. John Neilson, who was until recently assistant secretary and assistant treasurer of the New York & Stamford Electric Railway, and under the firm name of Bates & Neilson, will conduct a general practice of consulting electrical engineering, with offices in New York.

—Mr. George W. Fowler, who for several years has been connected with the engineering department of the C & C Electric Company, has resigned his position with that company and will hereafter be associated with Mr. George D. Beinert, the well-known electrical contractor, 32 Bible House, New York.

—Mr. T. H. Bailey Whipple has returned to the Sawyer-Man Electric Company to the position which he left last summer in order to take part in the reorganization of the Sales Department of the Nernst Lamp Company, of Pittsburg.

—Mr. Herman Johnson, has associated himself with the Acorn Engineering & Manufacturing Company, 27 Thames St., New York , in charge of shop operations.

—Dr. Joseph Hyde Pratt, of the Engineering Co. of America, is examining properties in North Carolina and South Carolina, investigating the tin and monazite deposits in those States.

—Mr. Albert E. Doe, Jr., formerly connected with The Norcross Bros. Co., of Boston, has severed his connection with that firm to take the position of New England salesman for the Thos. H. Dallett Co., of Philadelphia, manufacturers of stone working tools, portable drills, pneumatic hammers and other apparatus.

—Mr. W. S. Chase, sales manager for The National-Acme Manufacturing Company, has gone to England and the Continent on a business trip.

—Mr. W. P. Colton, advertising agent of the Delaware, Lackawanna & Western Railroad Co., will have his duties extended to include the Industrial Department, vice Mr. C. W. Ten Broeck promoted, with title of Industrial and Advertising Agent.

—Mr. John Leonard Kebler, vice-president and general manager of the Ward-Leonard Electric Company, died very suddenly on February 2nd, 1904, at Albuquerque, New Mexico.

Industrial Notes.

—The Silicate Stone Company, of 39 Wall St., New York, have acquired the American rights to Ford's silicate-of-lime stone process, which embodies a simple and cheap method of making artificial building stone in blocks of all sizes, stone brick, tiles and paving slabs. In consequence of the high cost of good natural building stone and the difficulty of obtaining any at all in many localities, attempts have been made, from time to time, to produce a good silicate-of-lime building stone, but Mr. L. P. Ford, of England, is the first who has succeeded in making it commercially in large blocks without cracks. His experiments extended over several years and cost a large sum of money, but he has been finally successful in producing an artificial stone of the highest quality in an economical manner. In the manufacture of this stone, the lime and the sand, at the high temperature and pressure employed, react upon each other, forming a cementitious silicate of lime, to the presence of which the great mechanical strength of the stone is largely due. The resistance of this stone to frost, corrosive atmospheres and sea water is high, and in many cases superior to that of natural stone. Its porosity is small, and it is very durable. On account of its uniform texture and strength, it can be worked and carved very easily, and its hardness can be varied to suit the purposes for which it is intended. Owing to its homogeneous structure, there is also no loss from irregularities and defects, as with natural stone. In appearance, the silicate-of-lime stone is like a fine or coarse-grained sand stone, and is of light or dark cream color, according to the sand used. By the addition of suitable coloring matters it can also be made in several other colors. This stone is manufactured in large or small blocks, to suit the convenience of the builder and the mason, who can work it as they please, and it is also made in the form of bricks, tiles and paving slabs. Arrangements for its manufacture in this country on a large scale are being made, and the Silicate Stone Company, of 39 Wall St., New York, will be glad to furnish full information to all who are interested in this new building material.

—The Allis-Chalmers Co., of Chicago, have widened their scope of manufacture and have engaged in the following new lines of work: Steam turbines; hydraulic machinery; gas engines; electrical machinery. As regards steam turbines, they have become associated with, and form part of, the Steam Turbine Advisory Syndicate, of England, which is composed of the Yarrow

Shipbuilding Co., the Tweedie (Vulcan) Shipbuilding Co., Willans & Robinson, and the Allis-Chalmers Company. Mr. Fullager, formerly chief engineer Parsons Steam Turbine Co., of England, is now consulting engineer for the Steam Turbine Advisory Syndicate. The steam turbines are of the horizontal type, and the Allis-Chalmers Co. are prepared to build sizes of from 500 to 5,000 kilowatts, and can, if required, build up to units of 10,000 kilowatts. Their license from the Advisory Turbine Syndicate concedes to them all of the United States, Canada and Mexico, with equal rights and privileges in South America, and rights to do business elsewhere in the Western Hemisphere. They have concluded arrangements with Escher-Wyss & Co., of Zürich, Switzerland, whereby they become the sole licensees for the Western Hemisphere, for the famous hydraulic machinery of this Swiss firm, some of whose apparatus has been installed at the Niagara Falls plant of the Cataract Construction Co., and whose turbine water wheels enjoy a world-wide reputation. The Allis-Chalmers Co. have bought the Western patents, and have become sole licensees, for the Western Hemisphere, of the Nürnberg Machine Co., Nuremberg, Germany, for the latter's gas engines, and are now prepared to make these engines up to any required horse power, suitable for use with blast-furnace gas or other kinds of gas. The Allis-Chalmers Co. have also entered into the manufacture of generators, motors, and electrical apparatus in all its branches, both for stationary and railroad work, power house installation for transportation purposes and electric lighting. They have engaged to take charge of this department of their business Mr. John F. Kelly, formerly of the Stanley Electric Co., Mr. William Stanley, of the same company, as consulting engineer, and Mr. John H. Kelman, formerly superintendent of the Stanley Company, as superintendent. These new branches of industry, combined with their celebrated reciprocating engines and other older lines of work, will enable the Allis-Chalmers Co. to take contracts for plete power plants of all descriptions and nish the best of their respective kinds.

he Quincy Engine Works, of Quincy, e builders of special machinery as well as builders of the Williams vertical engines, the Quincy Corliss engines and the Quincy four-plunger motor-driven pumps. They have just completed a set of ten special filter presses for a large glucose factory, together with a motor-driven four plunger hydraulic pump and hydraulic accumulator for operating them.

—The Acorn Electric & Manufacturing Company, of 27 Thames Street, New York, has changed its name to the Acorn Engineering & Manufacturing Company. This company is equipping a shop for all kinds of experimental and model work and general repairing, with Mr. Herman Jonson in charge of the shop operations.

—P. & F. Corbin, the New Britain, Conn. manufacturers of hardware, have issued a handsome book in commemoration of the semi-centennial of the incorporation of their company. This volume gives a history of the growth of a large organization from small beginnings, with interesting accounts of the men who have built up the business. There are many excellent portraits, views of the works, and other illustrations, all executed in artistic style, the printing and the paper are very good, the binding well made and tasteful, and the whole book forms a worthy memorial of an event which is of general interest on account of the high and wide reputation of the house of P. & F. Corbin, and is particularly remarkable in that the man who organized the company is its active head to-day.

—The American Electric Improvement Co., of Philadelphia, have recently installed their Clark electric water purifying plants at Gila Bend, Arizona, for the Southern Pacific Co., at Philadelphia, for the Puro Electro Water Co., and in Europe, and have also received orders from some manufacturing establishments. They guarantee that their apparatus will purify 360 gallons of Schuylkill River water at a cost of one cent.

—The Iron and Steel Institute will hold its annual general meeting at the Institution of Civil Engineers, in London, on May 5th and 6th, under the presidency of Mr. Andrew Carnegie, at which time the awards for the Carnegie Research Scholarship will be announced. The autumn meeting will take place in New York, on October 24th, 25th and 26th, after which there will be excursions to the St. Louis Exposition, Niagara Falls and some of the principal American cities. A committee has been formed in the United States for the reception of the Institute, with Mr. Charles Kirchhoff as president, and Mr. Theodore Dwight, of 99 John St., New York, as secretary.

—The Wellman-Seaver-Morgan Company, of Cleveland, Ohio, announce the opening of a Pittsburg office, located at 515 Frick Building, in charge of Mr. Willard N. Sawyer, Manager, for the convenience of the trade adjacent to Pittsburg. Mr. Sawyer has been with the company for a number of years, prior to which he was general superintendent of the Tennessee Coal, Iron & Railroad Company's Steel Works at Ensley, Alabama.

—The Bradley Manufacturing Company, of Pittsburg, have ready, for immediate shipment, one 160-horse-power, 3-line, compound Willans vertical central-valve engine, direct connected to a 100-kilowatt, 125-volt, direct-current, Western Electric Co. generator, both mounted on one base. This engine can be arranged for steam pressure ranging from 100 to 150 pounds, and for condensing or non-condensing.

—The Sprague Electric Company announces that its Baltimore office, which was destroyed in the recent fire, is now located in the Maryland National Bank Building.

—The General Electric Company has established a drafting room apprenticeship course, to which young men who are able to pass a satisfactory examination in arithmetic are eligible. The course is intended to fit applicants for drafting room positions. Further information can be obtained by application to Mr. J. W. Upp, Engineer in charge of Drafting Room, General Electric Company, Schenectady, N. Y.

—The Aultman & Taylor Machinery Co., of Mansfield, O., have secured through the Cahall Sales Department, W. W. Darley, general western agent, the largest instalment of boilers for the Louisiana Purchase Exposition at St. Louis. The instalment will consist of eight 508-H. P. and eight 400-H. P Cahall horizontal water-tube boilers, all equipped with the Mansfield chain grate stokers. The entire sixteen boilers will be equipped with induced draft, furnished by the Buffalo Forge Co.

—The Wm. H. Wilkinson Co., have moved into their new shops at West Medway, Mass., to which place all communications intended for them should be addressed. Their Boston representative is The Wm. H. Gallison Co., 36 Oliver St.

—Mason G. Worth & Co., have removed their offices to 1209 and 1210 Real Estate Trust Building, Philadelphia.

—The Rochester Gas Engine Company announces that it has re-organized, with J. S. Graham, President; J. J. Leary, Vice-President, and W. J. Graham, Secretary and Treasurer. Messrs. J. S. and W. J. Graham have been manufacturers of machinery in the city of Rochester for many years, under the name of The Graham Machine Company, and have recently disposed of their interests to the A. T. Hagen Company.

—W. H. Coverdale & Company have recently been incorporated to do a general engineering and contracting business, with offices at 66 Broadway, New York.

—Even the appalling fire which recently swept a large part of Baltimore out of existence will benefit some. The salvage companies, who salvage goods damaged by fire and sell them for the benefit of the fire insurance companies, will profit by this loss The goods damaged must be carefully dried before they become saleable, much depending upon the success of this drying. The Underwriters' Salvage Co., of New York City, recently placed an order with the B. F. Sturtevant Co., of Boston, for the complete equipment of a kiln for drying such goods by the Sturtevant fan system. The kiln is not only equipped with the Sturtevant apparatus for drying, consisting of a Sturtevant steam fan connected to a Sturtevant fireproof heater and galvanized iron distributing pipes, but the entire material and workmanship for making the rooms fireproof was furnished by the B. F. Sturtevant Co.

—The Roessler & Hasslacher Chemical Co., of 100 William St., New York, have issued a calendar, with an attractive picture in a tasteful frame.

—The Poole Engineering & Machine Company announce that their works at Woodberry were not injured by the recent destructive fire in Baltimore, but that their office on German St., was entirely destroyed, after the books and papers were removed

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... aggregating 11,000 horse-power. The ... in ... of head ... water-wheel ... the exception of ... demonstrate the facilities of ... especially large ... illustrated catalogue ... late date ... free to ... can be obtained by addressing ... Water Wheel Co., ... St., ... and 48 ... St., New York.

— ... manufacturing ... Columbus, Ohio, through their ... the Ohio Malleable Iron Company, ... same place, are now in the ... for high grade malleable castings.

— ... at the Armour Institute of Technology ... which contains the ... and is ... actual instruction to ... correspondence course.

— [illegible]

— [illegible]

— [illegible] ... currency.

NEW CATALOGUES AND TRADE PUBLICATIONS

These catalogues may be had free of charge on application to the firms issuing them.
Please mention The Engineering Magazine When you write.

Asbestos.

Booklet devoted to asbestos for theatre curtains, scenery, rope, upholstery, carpeting, walls and other uses, together with samples of asbestos theatre-curtain cloth, with and without interwoven wire. 6 by 3½ in.; pp. 4. H. W. Johns-Manville Co., 100 William street, New York.

Boilers.

Circulars, containing illustrations and descriptions of Mosher water-tube boilers, and tests of these boilers on the U. S. Monitor "Florida." Many torpedo boats and fast yachts have also been equipped with Mosher boilers, including the "Arrow," with a speed of 45 miles an hour; the "Ellide," 40 miles an hour, and others. 5½ by 9 in. Mosher Water-Tube Boiler Co., 1 Broadway, New York.

Bolt Machinery.

Catalogue D, containing illustrations and descriptions of Burdict bolt machinery, comprising square headers, hexagon headers, nut-burring machines, hot-pressed-nut machines, automatic threaders, pointers, nutters and tappers, and also of Schlenker bolt cutters. 9 by 6 in.; pp. 36. Howard Iron Works, Buffalo.

Concrete Mixers.

Circular with illustrations and descriptions of the Stanley Prismatic Drum concrete mixer for batch mixing, adapted for driving by steam, gasoline or electricity, and the Portable Gravity concrete mixer, for continuous mixing, with useful tables and information about concrete, cement and cement testing, mortar and artificial stone. 6 by 7 in.; pp. 8. Contractors' Plant Company, Boston.

Conduit.

Pamphlet, containing handsome illustrations and descriptions of bituminized fiber conduit for underground electrical work and various applications of this conduit, which is electrolysis proof and non-corrosive, moisture proof and non-abrasive. 7½ by 6½ in.; pp. 32. American Conduit Co., Los Angeles, Cal.

Counting Machines.

Circular, with return postal card, devoted to Durant counting machines, which are especially adapted to printing presses. 5½ by 3½ in.; pp. 8. W. N. Durant, 235 22d Street, Milwaukee.

Cranes.

Catalogue No. 15, with handsome half-tone illustrations and descriptions of large electric traveling cranes for steel works, machine shops and other establishments, as they appear in operation, and of their parts, with specifications and partial list of users. 9 by 12 in.; pp. 56. Also, catalogue No. 14, devoted to hand-power cranes of various types. 9 by 12 in.; pp. 15. The Case Manufacturing Co., Columbus O.

Electric Driving.

Bulletin No. 40, with illustrations and descriptions of electric motors for cranes and hoists of various kinds. 10 by 7½ in.; pp. 16. Also a number of flyers, with illustrated descriptions of various kinds of machine tools equipped with electric motors, and an account of a method of multiple-voltage, variable-speed control. 7 by 4½ in. Crocker-Wheeler Company, Ampere, N. J.

Electric Vehicles.

Circular No. 1059, containing descriptions and illustrations of electric motors, controllers, storage-battery indicators, and other parts of electric-vehicle motive-power equipments. 10 by 7 in.; pp. 24. Also circular No. 1032, devoted to electric railway motors; circular No. 1061, describing automobile charging outfits, and folder No. 4006, devoted to auxiliary apparatus for railway equipments. Westinghouse Electric & Manufacturing Co., Pittsburg.

Elevator.

Circular, illustrating and describing the Mabbs counterbalance electric elevator, in which the electric motor travels up and down vertical racks and counterbalances the car and its average load. 8½ by 3¾ in.; pp. 8. Mabbs Electric Elevator Co., Chicago.

Fireproof Construction.

Illustrated and descriptive catalogue of fireproof building material, including "Phœnix" hollow wall construction, red clay and glass roofing tiles and the "Herculean" terra cotta flat arch, with views of buildings employing these methods of construction and records of test. 9 by 6 in.; pp. 20. Henry Maurer & Son, 420 East 23d Street, New York.

Gasoline Engines.

Booklets and circulars devoted to gas, gasoline, distillate crude oil and kerosene engines for all purposes, and to dynamos and electric motors. Fairbanks, Morse & Co., Chicago.

Grab Buckets.

Circular No. 77, with illustrations and descriptions of grab buckets, made in three pieces, with very wide opening, which are absolutely self-filling, and will work in ore, mine-run coal, broken limestone, gravel and sand, and will also excavate in clay, gravel and soft earth of any nature. 3½ by 6 in.; pp. 12. The Jeffrey Manufacturing Co., Columbus, O.

Grate Bars.

Booklet describing and illustrating the Hall patent grate bar for steam boiler furnaces, kilns and other places, and giving a list of users of these grate bars. Also, an illustrated description of Stowell's compound-lever car mover. 6 by 3½ in.; pp. 16. Stowell Mfg. & Fdry. Co., South Milwaukee, Wis.

Industrial Railways.

Catalogue 038, containing illustrations and descriptions of narrow-gauge railways for manufacturing establishments, special tracks, a great variety of cars, electric locomotives and all other accessories, with views showing these railways in operation, and memoranda for engineers and architects. 9 by 6½ in.; pp. 52. C. W. Hunt Company, West New Brighton, Staten Island, N. Y.

Loose-Leaf Devices.

Catalogue of Tengwall "time savers," including loose-leaf files, ledgers, price books, scrap books, music books, binders, perforators and other loose-leaf devices. 9 by 6 in.; pp. 52. Tengwall File & Ledger Co., Chicago.

Machine Tools.

Catalogue, with illustrations and descriptions of tapping machines, riveting machines, screw slotters, speed indicators, round-belt cutter and punch, brass machine screws, and other machinery and tools. 7 by 5½ in.; pp. 31. Also catalogue No. 7, devoted to incandescent electric-lamp pull sockets and pull clusters and other high-grade electric specialties. 3½ by 6½ in.; pp. 59. Harvey Hubbell, Bridgeport, Conn.

Booklet, with illustrations and descriptions of modern high-standard lathes, planers, shapers, upright drills, radial drills and boring mills for rapid work production. 3½ by 6 in.; pp. 15. The American Tool Works Co., Cincinnati.

Overhead Tramway.

Catalogue No. 60, containing illustrations and descriptions of the Coburn patent carrying system or overhead tramway, and other styles of overhead trolleys for manufacturing plants, repair shops, packing and cold-storage houses and other establishments, regular and special forms of cranes and other kinds of conveying, unloading and hoisting machinery. 9 by 6 in.; pp. 32. New Jersey Foundry & Machine Co., 9-15 Murray Street, New York.

Piling.

Pamphlet, with illustrations and descriptions of interlocking channel-bar steel piling for cofferdams, bridge foundations, water-tight bulkheads, dry docks, dams, mine shafts, building foundations and deep excavations of all kinds, and views showing engineering works where this steel piling was used. 9 by 6 in.; pp. 40. Friestedt Interlocking Channel Bar Company, Chicago.

Pipe Machines.

Circular, with illustrations and descriptions of the Standard Wieland 6-inch pipe-threading and cutting machine, with adjustable expanding chasers for 1¼-inch to 6-inch pipe. 6 by 9 in.; pp. 4. Standard Engineering Co., Ellwood City, Pa.

Power Equipment

Bulletin, Series C, No. 3, containing a well-illustrated article, abstracted from *Power*, giving a description of the steam and electric power installation in the Mexican Central Railway Company's new shops at Aguascalientas. 10 by 7 in.; pp. 1[illegible]. D'Olier Engineering Company, Philadelphia.

Punches and Shears.

Catalogue, with illustrations and descriptions of punches and shears in various styles, for belt and hand power, bending rolls and woodworking machinery. 7 by 5 in.; pp. 31. Badger State Machine Co., Janesville, Wis.

Quartz Mill.

Catalogue No. 6, third edition, illustrating and describing the Huntington centrifugal roller quartz mill, for pulverizing gold ores, and other ore milling and concentrating machinery. 9 by 6 in.; pp. 18. Harron, Rickard & McCone, San Francisco.

Steam Engines.

Bulletin No. 8A, with illustrations and descriptions of Haberkorn automatic cut-off steam engines, and their parts, particularly the cylinder valve chambers and piston valves. 11 by 7½ in.; pp. 4. Haberkorn Engine Co., Fort Wayne, Ind.

Steam-Engine Test.

Booklet, the second number of the "Engineering Lore Series," containing an illustrated comprehensive description of a test of a horizontal tandem compound high-speed steam engine, made at Sibley College, Cornell University, by Prof. R. C. Carpenter. Buffalo Forge Company, Buffalo.

Watchman Clocks.

Pamphlet illustrating and describing the Howard electric clock and system for making a record of watchman's rounds, which is permanent and cannot be tampered with. The clocks may be also fitted with a program attachment. There is a long list of users of these clocks. 8 by 4 in.; pp. 32. The E. Howard Clock Co., Boston.

Water-Wheel Governors.

Circular, with illustrations of Sturgess water-wheel governors, and letters of recommendation. 9 by 6 in.; pp. 12. The Turbine Engineering Company, West Troy, N. Y.

Wire Cloth.

Price list of catalogue No. 21, giving information about Tyler double-crimped iron or steel wire cloth, brass or copper wire cloth, phosphor bronze wire cloth, heavy wire screen, and other kinds of wire cloth and screen. 6 by 3½ in.; pp. 63. The W. S. Tyler Company, Cleveland.

Wire-Rope Tramways.

Catalogue, containing comprehensive descriptions of wire-rope aerial tramways, with illustrations of a seventeenth century rope tramway, a piece of wire rope unearthed at Pompeii, and many modern installations of aerial tramways and other applications of wire rope. 7 by 9½ in.; pp. 50. Broderick & Bascom Rope Co., St. Louis, Mo.

Wrenches.

Booklet, with illustrations, description and prices of Keystone crocodile or alligator wrenches made of high-grade steel, properly and uniformly tempered. 5 by 3½ in.; pp. 4. Keystone Drop Forge Works, Chester, Pa.

THE ENGINEERING MAGAZINE

CONTENTS, MARCH, 1904

THE WORLD'S GREAT LABOR SAVERS AND LABOR SERVERS—
Inventions That Have Made Employment for Millions ROBERT W. HUNT 803
THE RISE OF LABOR THROUGH LABOR-SAVING MACHINERY—
Advances in Capacity, Skill, Wages and Social Status FRANK H. ROSE 836
THE PRIME MOVER AND ITS INFLUENCE ON THE WORLD'S PROGRESS—
Water Power and Steam as Agencies to Uplift Mankind JOHN E. SWEET 846
WHAT THE INVENTOR HAS DONE FOR THE RAILWAY WORKER—
Labor-Saving Devices the Basis of the Railway's Growth A. M. WAITT 872
HYDRAULIC POWER APPLIANCES IN THE ENGINEERING INDUSTRIES—
Their Great Economy and Efficiency in Special Services GEORGE H. BAXTER 878
LABOR-SAVING MACHINERY IN FOUNDRY OPERATIONS—
Modern Practice, and the Gain to Employer and Employee RICHARD MOLDENKE 896
THE DEVELOPMENT OF POWER-DRIVEN MACHINERY IN THE MINE—
Appliances that Make a Vast Mineral Industry Possible E. H. ROBERTON 925
MECHANICAL AUXILIARIES TO THE ECONOMY OF THE FIRE ROOM—
Skilled Intelligence Replacing the Toil of the Stoker R. P. BOLTON 950
THE RELATION OF ELECTRICAL INVENTIONS TO HUMAN ACTIVITY—
How they Lighten Work, Enlarge Output, and Give Employment LOUIS BELL 967

REVIEW OF THE ENGINEERING PRESS

The Production of Radium by Extraction from the Ore—981
Influence of Engineering Education—Science and the Universities—983
Recent Experimental Determinations of the Specific Heat of Steam—985
Multiple-Propulsion Trains for Mechanical Road Traction—986
Latest Developments of the Single-Phase Electric Motor for Railways—988
Report of the Alloys Research Committee on the Heat-Treatment of Steel—991
Electrical Statistics in Germany—Development of Generating Stations—993
Gas Engines in Railroad Work for Pumping, Inspection, Motive Power—994
Railway Construction in Switzerland—The Engadine Lines—996
Abuses and Possible Remedies in Patent-Law Administration—997
Technical Education in Germany—British and German Methods—999
The Nature of Invention—Development of Scientific Methods—1001
Modifications in Design of Machine Tools for High-Speed Steel—1002
The Maintenance of Open Harbors by Modern Ice Breakers—1003

THE ENGINEERING INDEX

With Descriptive Notes Clearly Indicating the Character and Purpose of Current Leading Articles in the Technical Press of the World.

CIVIL ENGINEERING 1005
ELECTRICAL ENGINEERING . . . 1010
GAS-WORKS ENGINEERING 1017
INDUSTRIAL ECONOMY 1017
MARINE AND NAVAL ENGINEERING . 1019
MECHANICAL ENGINEERING . . . 1020
MINING AND METALLURGY 1027
RAILWAY ENGINEERING 1032
STREET AND ELECTRIC RAILWAYS, 1034

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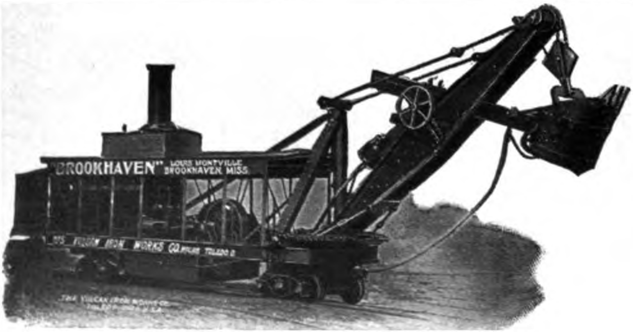
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THE ENGINEERING MAGAZINE,

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AUTHORS AND PAPERS FOR MARCH, 1904.

ROBERT W. HUNT *(The World's Great Labor Savers and Labor Servers)*—Born 1838; educated Covington, Ky.; worked in a Pottsville rolling mill and learned practically the processes of iron manufacture; in 1859-60 studied chemistry and became chemist to the Cambria Iron Co.; entered the army during the U. S. civil war, and rose to rank of captain; in 1865 became superintendent of steel works at Wyandotte, Mich., then returned to the Cambria Co. and was with them until 1873; with John A. Griswold & Co., Troy, 1873-75; with the Troy Steel & Iron Co., 1875-88. Since 1888, head of Robert W. Hunt & Co., consulting engineers, Chicago. Member of the Institution of Civil Engineers, the Institution of Mechanical Engineers, the Iron & Steel Institute, the American Society of Civil Engineers, the American Society of Mechanical Engineers (president 1891), the American Institute of Mining Engineers (president 1883-84), the Western Society of Engineers, etc.

FRANK H. ROSE *(The Effects of Labour-Saving Machinery)*—Born in Lambeth, and educated in a London elementary school, continuing with night school classes for some years after beginning work. Apprenticed to Maudslay, Sons & Field 1872-78; the great trade depression of the ensuing years gave him early experience of the hardships of the wage earner, and influenced his thought upon industrial questions; joined the Lambeth branch of the Amalgamated Society of Engineers in 1878, and until the last three years was almost continually in office in the society; in 1893 was appointed one of the six district organisers and went to live in Liverpool; then received an appointment in Manchester which he held until April, 1903, until his Parliamentary candidature rendered other arrangements necessary. His present connections are journalistic.

JOHN E. SWEET *(The Prime Mover and Its Influence on the World's Progress)*—Born 1832; educated in district schools; farmer's boy, then carpenter's apprentice until 1850; builder and architect in the southern States until 1861; inventor and mechanical draughtsman until 1873; professor practical mechanics, Cornell University, 1873-79; expert and juror, World's Columbian Exposition, 1893, on machine tools; first president Engine Builders' Association of the United States, 1899-1901; founder of the American Society of Mechanical Engineers (president 1883-84).

ARTHUR M. WAITT *(What the Inventor Has Done for the Railway Worker)*—Until 1903 superintendent of motive power and rolling stock of the New York Central & Hudson River Railway; member of the American Society of Mechanical Engineers (vice-president 1900-1902).

GEORGE HANDYSIDE BAXTER *(Hydraulic Power Appliances in the Engineering Industries)*—Mechanical engineer. Educated at High School, Dundee; served apprenticeship with Gourlay Bros. & Co. of that city, and after a short time with John Elder & Co., now the Fairfield Shipbuilding Co., Ltd., as a draughtsman, entered in 1872 the service of the Barrow Shipbuilding Co., now Vickers, Maxim, Ltd., as chief draughtsman in their engine department; in 1881 removed to the firm of Ramage & Ferguson, shipbuilders, Leith, as constructor and manager of their new engine works. From thence in 1889 engaged in a similar capacity with Barclay Aule & Co., Ltd., shipbuilders and engineers, Glasgow, and in 1892 joined the service of the Clyde Navigation Trust as their mechanical engineer and manager of their large repairing works at Dalmuir; member of the Institution of Engineers and Shipbuilders in Scotland since 1881.

AUTHORS AND PAPERS FOR MARCH, 1904.

DR. RICHARD MOLDENKE *(Labor-Saving Machinery in Foundry Operation)*—**Born Wa town, Wis., 1864; graduated from Columbia University, 1885, with degree of Ph. D. A specialist in metallurgy of cast iron and expert in malleable castings, and an extensive writer on the metallurgy iron and steel. Was for some years in Pittsburg; at present is Secretary of the American Foundrym Association.** Dr. Moldenke has taken very active interest in the work of the **International Associat** for Testing Materials.

E. H. ROBERTON *(The Development of Power-Driven Machinery in the Mine)*—**Born in the W** Riding of Yorkshire, 1877, but has lived almost all his life in Northumberland, the centre of the Bri mining industry; educated at Leatherhead School, gaining an open mathematical scholarship to Ch Church, Oxford; graduated in the Honours School of Mathematics in 1899; studied engineering at Rutl ford College, Newcastle-on-Tyne, and worked for more than three years in the mines of the Sea Delaval Coal Co., Ltd.; in 1892 accepted the post of demonstrator of mining at the University of Birmi ham, and has since assisted Professor Redmayne in his work in connection with the studies and investi tions of the Royal Coal Commission.

REGINALD PELHAM BOLTON *(Mechanical Auxiliaries to the Economy of the Fire-Room,* Born and apprenticed in England; served as assistant engineer at the Edgemoor Iron Works and as ass ant to Dr. Erasmus Leavitt; has been in practice in New York City since 1895 on the equipment of la buildings, having designed, within the last few years, the equipment of the Bowling Green offices, t Grand Central Station, the Royalton and Lorraine hotels. He originated the vertical system of elect wiring and duplex-pressure hydraulic-elevator system; has been in charge of the remodeling of the Rid wood Pumping Station for the City of Brooklyn, before and since its incorporation with the city of N York, from 1896 to 1900; associate member of the Institution of Civil Engineers, member of the Americ Society of Civil Engineers, and of the American Society of Mechanical Engineers.

LOUIS BELL *(The Relation of Electrical Inventions to Human Activity)*—Graduated from Da mouth College, 1884, and took the degree of Ph. D. at Johns Hopkins University, 1888; professor Physics and Applied Electricity at Purdue University, Lafayette, Ind., 1888-89; consulting engine Chicago (firm of Bliss & Bell), 1889; editor of *The Electrical World*, N. Y., 1890-91; member A. I. E. I 1890; engineer in charge of power-transmission work of the General Electric Co., 1892-95; at prese consulting engineer, Boston, Mass., making a specialty of power transmission and heavy electric-railw work. Dr. Bell's wide range of experience in all fields of electric practice enables him to discuss l topic with matchless authority.

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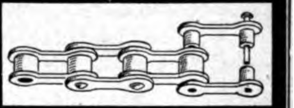

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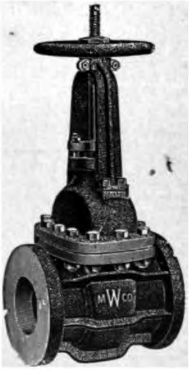

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131

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B. F. Sturtevant Co., Jamaica Plain Station, Boston, Mass.

Blue Print Machinery.

American Drafting Furniture Co., Rochester, N. Y.
Pittsburg Blue Print Co., Pittsburg, Pa.
Keuffel & Esser Co., 127 Fulton St., New York.
Williams, Brown & Earle, 918 Chestnut St., Philadelphia, Pa.

Boiler Compounds

Eagle Oil & Supply Co., 104 Broad St., Boston, Mass.
John Simmons Co., 110 Centre St., New York.

Boiler Fronts and Fittings.

John Simmons Co., 110 Centre St., New York.
Vulcan Iron Works, Toledo, Ohio.
Walworth Manufacturing Co., Boston, Mass.

Boiler Inspectors.

Hartford S. B. I. & Ins. Co., Hartford, Conn.

Boiler-Makers' Tools.

Hilles & Jones Co., Wilmington, Del.
Niles-Bement-Pond Co., 136 Liberty St., New York.
Philadelphia Pneumatic Tool Co., Philadelphia, Pa.
Pratt & Whitney Co., Hartford, Conn.
Stow Flexible Shaft Co., Philadelphia, Pa.

Boilers.

Allis-Chalmers Co., Chicago, Ill.
American Well Works, Aurora, Ill.
Atlantic Works, East Boston, Mass.
Atlas Engine Co., Indianapolis, Ind.
Aultman Company, Canton, Ohio.
Babcock & Wilcox Co., 85 Liberty St., New York.
Bradley Mfg. Co., Pittsburg, Pa.
Caball Sales Department, Pittsburg, Pa.
Contractors' Supply & Equipment Co., Chicago, Ill.
Harrison Safety Boiler Works, 3138 N. 17th St., Philadelphia, Pa.
Harron, Rickard & McCone, 21 Fremont St., San Francisco, Cal.
Heine Safety Boiler Co., St. Louis, Mo.
Kingsford Foundry & Machine Co., Oswego, N. Y.
P. B. McCabe & Co., 602 N. Main St., Los Angeles, Cal.
Riter-Conley Mfg. Co., Pittsburg, Pa.
S. Morgan Smith Co., York, Pa.
Stirling Co., Chicago, Ill.
Struthers-Wells Co., Warren, Pa.
Robt. Wetherill & Co., Chester, Pa.
Wickes Bros., Saginaw, Mich.

Boiler Tube Cleaners.

Wm. B. Pierce Co., Buffalo, N. Y.

Bolt and Nut Machinery.

Acme Machinery Co., Cleveland, Ohio.
The National Machinery Co., Tiffin, O.
Niles-Bement-Pond Co., 136 Liberty St., New York.

Books.

Association of Engineering Societies, Phila., Pa.
Henry Carey Baird & Co., 810 Walnut St., Philadelphia, Pa.
Derry-Collard Co., 256-257 Broadway, New York.
Frederick J. Drake & Co., 211 E. Madison St., Chicago, Ill.
Eng'g Magazine Press, 120-122 Liberty St., N. Y.
John Wiley & Sons, 43 E. 19th St., New York.

Boring Bars.

H. B. Underwood & Co., 1025 Hamilton St., Philadelphia, Pa.

Boring Mills.

Bullard Machine Tool Co., Bridgeport, Conn.
Frank Machinery Co., Buffalo, N. Y.
Niles-Bement-Pond Co., 136 Liberty St., New York.
Pond Machine Tool Co., Plainfield, N. J.
Wm. Sellers & Co., Inc., Philadelphia, Pa.

Box Makers'

J. A. Fay &
cinnati, O

Brass Founde

The S. Obermi

Brick.

Henry Maurer
Pennsylvania

Brick and Til

American Blo
Jeffrey Mfg.
Vulcan Iron

Bridge Timb

American Lun

Buckets, Auto

Hayward Co.,

Bulldozers.

National Mac
Niles-Bement-

Cable-Railwa

Allis-Chalmer
A. Leschen &
John A. Mead
Poole Enginee

Cables, Electri

General Elect
Sprague Elect

Cableways—S

Lambert Hois
Lidgerwood M

Cables, Wire.

Broderick & B.
Cooper, Hewit
A. Leschen &
Lidgerwood M
Trenton Iron

Calculating M

Calculagraph
Keuffel & Ess

Carborundum.

Carborundum

Card Index S

Globe-Wernick

Cars.

Arthur Koppe
Wonham-Mag
G. L. Stuebne

Car Shop Mac

J. A. Fay &
cinnati, O
Hilles & Jone
Niles-Bement-
Pond Machin
Pratt & Whit

Carriage and

American Blo
J. A. Fay &
cinnati,
Stow Flexibl
Stow Manufa

Castings, Iron,

E. R. Allen
Allis-Chalmer
Aultman Con
Buffalo Found
Buhl Malleab
Christensen E
Diamond Dril
Stanley G. F
A. A. Griffi
York; W
Jeffrey Mfg.
Maryland St
Pennsylvania
Poole Engine

For Alphabetical Index to Advertisers see insi

Quincy Engine Works, Quincy, Ill.
Paul S. Reeves & Son, Philadelphia, Pa.
E. M. Shaw, Providence, R. I.
John Simmons Co., 110 Centre St., New York.
Southwark Foundry & Machine Co., Phila., Pa.
Walworth Manufacturing Co., Boston, Mass.
Robt. Wetherill & Co., Chester, Pa.

Cast-Iron Pipe.

McNab & Harlin Mfg. Co., 56-60 John St., N. Y.
Pittsburg Valve, Fdy. & Cons. Co., Pittsburg, Pa.
John Simmons Co., 110 Centre St., New York.
U. S. Cast Iron Pipe & Fdy. Co., Philadelphia, Pa.
Walworth Manufacturing Co., Boston, Mass.
R. D. Wood & Co., Philadelphia, Pa.

Catalogue Covers.

Tengwall File & Ledger Co., Chicago, Ill.

Cement Machinery.

Allis-Chalmers Co., Chicago, Ill.
Bethlehem Fdy. & Mch. Co., South Bethlehem, Pa.
H. W. Caldwell & Sons Co., Chicago, Ill.
Dodge Mfg. Co., Mishawaka, Ind.
W. D. Dunning, Syracuse, N. Y.
Jeffrey Mfg. Co., Columbus, Ohio.
Link-Belt Eng'g Co., Nicetown, Philadelphia, Pa.
F. L. Smidth & Co., 66 Maiden Lane, New York.
E. H. Stroud & Co., Chicago, Ill.
Vulcan Iron Works Co., Toledo, Ohio.

Cement—Portland.

American Cement Co., Philadelphia, Pa.
Atlas Portland Cement Co., 30 Broad St., N. Y.
Edison Portland Cement Co., Philadelphia, Pa.
Kelley Island Lime & Transport Co., Cleveland, O.
Lawrence Cement Co., 1 Broadway, New York.

Chains.

Buhl Malleable Co., Detroit, Mich.
Morse Chain Co., Trumansburg, N. Y.

Chain Belting.

Aultman Company, Canton, Ohio.
H. W. Caldwell & Sons Co., Chicago, Ill.
Case Mfg. Co., Columbus, Ohio.
Jeffrey Manufacturing Co., Columbus, Ohio.
Link-Belt Eng'g Co., Nicetown, Philadelphia, Pa.

Chain Joint.

Morse Chain Co., Trumansburg, N. Y.

Chain Making Machinery (Welded Chain).

Turner, Vaughn & Taylor Co., Cuyahoga Falls, O.

Chemicals.

F. W. Braun & Co., Los Angeles, Cal.
Roessler & Hasslacher Chem. Co., 100 William St., New York.

Chemical Works Machinery.

Atlantic Works, East Boston, Mass.

Chemists.

Chas. Catlett, Staunton, Va.
L. B. Darling, 79 Sabin St., Providence, R. I.
Robt. W. Hunt & Co., Chicago, Ill.

Chucks

American Tool & Machine Co., Boston, Mass.
Niles-Bement-Pond Co., 136 Liberty St., New York.
Standard Tool Co., Cleveland, Ohio.

Circuit Breakers.

The Cutter Co., Philadelphia, Pa.

Clay-Working Machinery.

American Blower Co., Detroit, Mich.
Aultman Company, Canton, Ohio.
Jeffrey Mfg. Co., Columbus, Ohio.
Link-Belt Eng'g Co., Nicetown, Philadelphia, Pa.
E. H. Stroud & Co., Chicago, Ill.
Turner, Vaughn & Taylor Co., Cuyahoga Falls, O.
Vulcan Iron Works, Toledo, Ohio.

Clocks—Time Recording.

E. Imhauser & Co., 206 Broadway, New York.

Clutch Pulleys.

H. W. Caldwell & Sons Co., Chicago, Ill.
Case Mfg. Co., Columbus, Ohio.
Dodge Mfg. Co., Mishawaka, Ind.

Coal and Ashes-Handling Machinery.

Aultman Company, Canton, Ohio.
Broderick & Bascom Rope Co., St. Louis, Mo.
H. W. Caldwell & Sons Co., Chicago, Ill.
The Hayward Co., 97 Cedar St., New York.
C. W. Hunt Co., West New Brighton, New York.
Jeffrey Mfg. Co., Columbus, Ohio.
Arthur Koppel, 66 Broad St., New York.
A. Leschen & Sons Rope Co., St. Louis, Mo.
Link-Belt Eng'g Co., Nicetown, Philadelphia, Pa.
John A. Mead Mfg. Co., 11 Broadway, New York.
Robins Conveying Belt Co., 14-22 Park Row, N. Y.

Coal-Mining Machinery.

Allis-Chalmers Co., Chicago, Ill.
Broderick & Bascom Rope Co., St. Louis, Mo.
Geo. F. Blake Mfg. Co., 114 Liberty St., New York.
General Electric Co., New York.
C. W. Hunt Co., West New Brighton, New York.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
Jeffrey Manufacturing Co., Columbus, Ohio.
Knowles Steam Pump Wks., 114 Liberty St., N. Y.
Arthur Koppel, 68 Broad St., New York.
Laidlaw-Dunn-Gordon Co., 116 Liberty St., N. Y.
Lambert Hoisting Engine Co., Newark, N. J.
A. Leschen & Sons Rope Co., St. Louis, Mo.
Link-Belt Eng'g Co., Nicetown, Philadelphia, Pa.
John H. McGowan Co., Cincinnati, Ohio.
Norwalk Iron Works, South Norwalk, Conn.
Rand Drill Co., 128 Broadway, New York.
Robins Conveying Belt Co., 14-22 Park Row, N. Y.
Triumph Electric Co., Cincinnati, Ohio.
Vulcan Iron Works Co., Toledo, Ohio.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Coal Screens.

Allis-Chalmers Co., Chicago, Ill.
Hendrick Mfg. Co., Ltd., Carbondale, Pa.
Jeffrey Manufacturing Co., Columbus, Ohio.
Link-Belt Eng'g Co., Nicetown, Philadelphia, Pa.
John A. Mead Mfg. Co., 11 Broadway, New York.

Concentrators.

P. B. McCabe & Co., 602 No. Main St., Los Angeles, Cal.
Harron, Rickard & McCone, San Francisco, Cal.

Concrete Mixers.

Contractors' Supply & Equipment Co., Chicago, Ill.
W. D. Dunning, Syracuse, N. Y.
Ransome Concrete Mchy. Co., 11 B'way, N. Y. C.

Condensers.

Alberger Condenser Co., 95 Liberty St., New York.
Allis-Chalmers Co., Chicago, Ill.
Geo. F. Blake Mfg. Co., 114 Liberty St., New York.
Deane Steam Pump Co. of Holyoke, 116 Liberty St., New York.
Guild & Garrison, Brooklyn, N. Y.
Knowles Steam Pump Wks., 114 Liberty St., N. Y.
Laidlaw-Dunn-Gordon Co., 116 Liberty St., N. Y.
John H. McGowan Co., Cincinnati, Ohio.
Snow Steam Pump Works, 116 Liberty St., N. Y.
Southwark Foundry & Machine Co., Phila., Pa.
Struthers-Wells Co., Warren, Pa.
Wheeler Condenser & Engineering Co., 120 Liberty St., New York.
Henry R. Worthington, 118 Liberty St., New York

Conduits.

American Conduit Co., 336 Macy St., Los Angeles, Cal.

Construction Timbers (Yellow Pine).

American Lumber & Mfg. Co., Pittsburg, Pa.

Controllers.

The Cutler-Hammer Mfg. Co., Milwaukee, Wis.
Power & Speed Controller Co., Boston, Mass.
Ward Leonard Elec. Co., Bronxville, N. Y.

Conveying Machinery.

Aultman Company, Canton, Ohio.
Borden & Selleck Co., Chicago, Ill.
Broderick & Bascom Rope Co., St. Louis, Mo.
Browning Engineering Co., Cleveland, O.
Buhl Malleable Co., Detroit, Mich.
H. W. Caldwell & Sons Co., Chicago, Ill.
Frick Company, Waynesboro, Pa.
Hayward Co., 97 Cedar St., New York.
C. W. Hunt Co., West New Brighton, New York.
Jeffrey Mfg. Co., Columbus, Ohio.
Arthur Koppel, 68 Broad St., New York.
A. Leschen & Sons Rope Co., St. Louis, Mo.
Lidgerwood Mfg. Co., 96 Liberty St., New York.
Link-Belt Eng'g Co., Nicetown, Philadelphia, Pa.
John A. Mead Mfg. Co., 11 Broadway, New York.
Minneapolis Steel & Machinery Co., Minneapolis, Minn.
Robins Conveying Belt Co., 14-22 Park Row, N. Y.
Trenton Iron Co., Trenton, N. J.

Cooling Towers.

Alberger Condenser Co., 95 Liberty St., New York.
Wheeler Condenser & Engineering Co., 120 Liberty St., New York.
Henry R. Worthington, New York City.

Copper.
Orford Copper Co., 74 Broadway, New York.

Cornices.
G. Drouvé & Co., Bridgeport, Conn.

Corrugated Iron.
Garry Iron & Steel Co., Cleveland, Ohio.

Cost Systems.
Baker-Vawter Co., Chicago, Ill.
Cost-System & Auditing Co., 45 B'way, New York.
Hugo Diemer, Lawrence, Kansas.
Gunn & Richards, 30 Pine St., New York.
David Townsend, 624 Witherspoon Bldg., Phila., Pa.

Counting Machines.
W. N. Durant Co., 235 22d St., Milwaukee, Wis.

Crane Motors.
Northern Electrical Mfg. Co., Madison, Wis.

Cranes.
American Hoist & Derrick Co., St. Paul, Minn.
Browning Engineering Co., Cleveland, Ohio.
Chicago Pneumatic Tool Co., Chicago, Ill.
Case Mfg. Co., Columbus, Ohio.
Garry Iron & Steel Co., Cleveland, Ohio.
Hayward Co., 97 Cedar St., New York.
Industrial Works, Bay City, Mich.
Niles-Bement-Pond Co., 136 Liberty St., New York.
The S. Obermayer Co., Cincinnati, Ohio.
Pedrick & Ayer Co., Philadelphia, Pa.
Riter-Conley Mfg. Co., Pittsburg, Pa.
Wm. Sellers & Co., Philadelphia, Pa.
Shaw Electric Crane Co., Muskegon, Mich.
R. D. Wood & Co., Philadelphia, Pa.

Creosoting.
Samuel Cabot, 70 Kilby St., Boston, Mass.

Crucibles.
F. W. Braun & Co., Los Angeles, Cal.
Jos. Dixon Crucible Co., Jersey City, N. Y.
The S. Obermayer Co., Cincinnati, Ohio.

Crushers—Ore, Phosphate, Rock.
Allis-Chalmers Co., Chicago, Ill.
Aultman Company, Canton, Ohio.
F. W. Braun Co., Los Angeles, Cal.
Card & Weber Machine Co., Denver, Colo.
Diamond Drill & Machine Co., Birdsboro, Pa.
Harron, Rickard & McCone, 21 Fremont St., San Francisco, Cal.
F. L. Smidth & Co., 66 Maiden Lane, New York.
E. H. Stroud & Co., Chicago, Ill.
Sturtevant Mill Co., Boston, Mass.

Crusher Rings and Shells (Steel).
Latrobe Steel Co., Philadelphia, Pa.

Cupel Machines.
F. W. Braun Co., Los Angeles, Cal.

Cupolas.
Northern Engineering Works, Detroit, Mich.
The S. Obermayer Co., Cincinnati, Ohio.
Riter-Conley Mfg. Co., Pittsburg, Pa.
F. B. Stevens, Detroit, Mich.

Cutters, Milling.
Becker-Brainard Milling Machine Co., Hyde Park, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Standard Tool Co., Cleveland, Ohio.

Diamond Drills.
American Diamond Rock Drill Co., 95 Liberty St., New York.
American Well Works, Aurora, Ill.
Davis Calyx Drill Co., 128 Broadway, New York.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
Rand Drill Co., 128 Broadway, New York.

Digesters.
Atlantic Works, East Boston, Mass.
Riter-Conley Mfg. Co., Pittsburg, Pa.
Robt. Wetherill & Co., Chester, Pa.

Draught Gauges.
Hohmann & Maurer Mfg. Co., Rochester, N. Y.

Draftsmen's Instruments and Materials.
Theo. Alteneder & Sons, Philadelphia, Pa.
Brandis Sons Co., Brooklyn, N. Y.
Brown & Sharpe Mfg. Co., Providence, R.
Buff & Buff Mfg. Co., J. Plain Sta., Boston, Mass.
Eugene Dietzgen Co., 181 Monroe St., Chicago, Ill.
Keuffel & Esser Co., 127 Fulton St., New York.
Universal Drafting Machine Co., 220 Seneca St., Cleveland, Ohio.

Drawing Tables.
American Drafting Furniture Co., Rochester, N.

Dredges—SEE EXCAVATORS.

Drilling Machines.
W. F. & John Barnes Co., Rockford, Ill.
Baush Machine Tool Co., Springfield, Mass.
Bickford Drill & Tool Co., Cincinnati, Ohio.
Chicago Pneumatic Tool Co., Chicago, Ill.
Cleveland Punch & Shear Works, Cleveland, Oh
Thos. H. Dallett & Co., Philadelphia, Pa.
Diamond Drill & Machine Co., Birdsboro, Pa.
Hisey-Wolf Machine Co., Cincinnati, O.
Philadelphia Pneumatic Tool Co., Philadelphia,
Pond Machine Tool Co., Plainfield, N. J.
Pratt & Whitney Co., Hartford, Conn.
Wm. Sellers & Co., Inc., Philadelphia, Pa.
Stow Flexible Shaft Co., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.

Drills—Rock and Coal.
American Diamond Rock Drill Co., 95 Liberty S New York.
Clayton Air Compress Wks., 120 Liberty St., N.
Davis Calyx Drill Co., 128 Broadway, New York.
Hall Steam Pump Co., Pittsburg, Pa.
Harron, Rickard & McCone, 21 Fremont St., Francisco, Cal.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N.
Jeffrey Mfg. Co., Columbus, Ohio.
Rand Drill Co., 128 Broadway, New York.
Standard Diamond Drill Co., 108 La Salle St., Cl cago, Ill.

Drop Forging Machinery.
Scranton & Co., 39 Church St., New Haven, Conn.

Drop Forgings.
Globe Machine & Stamping Co., Cleveland, Ohio.

Drying and Calcining Machines.
American Blower Co., Detroit, Mich.
Harrison Safety Boiler Works, 3138 N. 17th Philadelphia, Pa.
Jeffrey Mfg. Co., Columbus, Ohio.
B. F. Sturtevant Co., Jamaica Plain Station, ton, Mass.

Dynamos.
American Engine Co., Bound Brook, N. J.
Bullock Electric Mfg. Co., Cincinnati, Ohio.
Christensen Engineering Co., Milwaukee, Wis.
Crocker-Wheeler Co., Ampere, N. J
C & C Electric Co., 143 Liberty St., New York.
Guarantee Electric Co., Chicago, Ill.
General Electric Co., New York.
Jantz & Leist Electric Co., Cincinnati, Ohio.
Jeffrey Mfg. Co., Columbus, Ohio.
National Electric Co., Milwaukee Wis.
Northern Electrical Mfg. Co., Madison, Wis.
Robbins & Myers Co., Springfield, Ohio.
Sprague Electric Co., 527 W. 34th St., New York
B. F. Sturtevant Co., Jamaica Plain Station, ton, Mass.
Triumph Electric Co., Cincinnati, Ohio.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Ejectors,
Hancock Inspirator Co., 85 Liberty St., New York
Hayden & Derby Mfg. Co., New York.
Watson & McDaniel Co., Philadelphia, Pa.

Electric Clocks.
E. Imhauser & Co., 206 Broadway, New York.

Electric Counters.
W. N. Durant Co., 235 22d St., Milwaukee, Wis.

Electric Hoists.
Browning Engineering Co., Cleveland, O.
C & C Electric Co., New York, N. Y.
C. W. Hunt Co., West New Brighton, N. Y.
Lambert Hoisting Engine Co., Newark, N. J.
Lidgerwood Mfg. Co., 96 Liberty St., New York.
Niles-Bement-Pond Co., 136 Liberty St., New York.
Northern Engineering Works, Detroit, Mich.
Shaw Electric Crane Co., Muskegon, Mich.
Sprague Electric Co., 527-531 W. 34th St., N. Y.

Electric Heating Apparatus.
Simplex Electric Heating Co., Cambridgeport, Mass.

Electrical Machinery and Supplies.
American Engine Co., Bound Brook, N. J.
Geo. F. Blake Mfg. Co., 114 Liberty St., New York.
Bristol Co., Waterbury, Conn.
Broderick & Bascom Rope Co., St. Louis, Mo.
Bullock Electric Mfg. Co., Cincinnati, Ohio.
C & C Electric Co., 143 Liberty St., New York.

For Alphabetical Index to Advertisers see inside back cover.

Christensen Engineering Co., Milwaukee, Wis.
Crocker-Wheeler Co., Ampere, N. J.
The Cutter Co., Philadelphia, Pa.
The Cutler-Hammer Mfg. Co., Milwaukee, Wis.
Deane Steam Pump Co. of Holyoke, 116 Liberty St., New York.
General Electric Co., New York.
Hisey-Wolf Machine Co., Cincinnati, O.
Jantz & Leist Electric Co., Cincinnati, Ohio.
Jeffrey Mfg. Co., Columbus, Ohio.
Knowles Steam Pump Wks., 114 Liberty St., N. Y.
Laidlaw-Dunn-Gordon Co., 116 Liberty St., N. Y.
National Electric Co., Milwaukee, Wis.
Northern Electrical Mfg. Co., Madison, Wis.
Wm. E. Quimby, Inc., 86 Liberty St., New York.
Quincy Engine Works, Quincy, Ill.
The Robbins & Myers Co., Springfield, Ohio.
Snow Steam Pump Works, 116 Liberty St., N. Y.
Sprague Electric Co., 527 W. 34th St., New York.
B. F. Sturtevant Co., Jamaica Plain Station, Boston, Mass.
Triumph Electric Co., Cincinnati, Ohio.
Ward Leonard Electric Co., Bronxville, N. Y.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.
Westinghouse, Church, Kerr & Co., 26 Cortlandt St., New York.
Weston Elec. Inst. Co., Waverly Pk., Essex Co., N.J.
Henry R. Worthington, 118 Liberty St., New York.

Elevators.

American Tool & Machine Co., Boston, Mass.
Aultman Co., Canton, Ohio.
Borden & Selleck Co., Chicago, Ill.
Buhl Malleable Co., Detroit, Mich.
H. W. Caldwell & Sons Co., Chicago, Ill.
Jeffrey Mfg. Co., Columbus, Ohio.
Link-Belt Eng'g Co., Nicetown, Philadelphia, Pa.
John A. Mead Mfg. Co., 11 Broadway, New York.
Minneapolis Steel & Machinery Co., Minneapolis, Minn.
Morse Elevator Works, Philadelphia, Pa.
The S. Obermayer Co., Cincinnati, Ohio.
Poole Engineering & Machine Co., Baltimore, Md.
Triumph Electric Co., Cincinnati, Ohio.

Emery Wheel Dressers.

Globe Machine & Stamping Co., Cleveland, Ohio.

Emery Wheels.

Carborundum Co., Niagara Falls, N. Y.
Frank Machinery Co., Buffalo, N. Y.
Stow Flexible Shaft Co., Philadelphia, Pa.

Employment Bureau.

Engineering Agency, Monadnock Blk., Chicago, Ill.
Hapgoods, 309 Broadway, New York.

Engineering Instruments.

Theo. Alteneder & Sons, Philadelphia, Pa.
Brandis Sons Co., Brooklyn, N. Y.
Buff & Buff Mfg. Co., Boston, Mass.
Eugene Dietzgen Co., Chicago, Ill.
Keuffel & Esser Co., New York City.
Young & Sons, Philadelphia, Pa.

Engineers, Civil.

Engineering Co. of America, 74 B'way, New York.
Robert W. Hunt & Co., 1121 The Rookery, Chicago, Ill.
Chas. C. Moore & Co., San Francisco, Cal.
Sydney F. Reynolds, Torrey, Pa.
A. W. Robinson, Montreal, Canada.

Engineers, Electrical.

Crocker-Wheeler Co., Ampere, N. J.
Engineering Co. of America, 74 B'way, New York.
Robt. McF. Doble, 314 Hayward Bldg., San Francisco, Cal.
W. K. Palmer, 401 N. Y. Life Bldg., Kansas City, Mo.
Sydney F. Reynolds, Torrey, Pa.
Philip K. Stern, 130 Fulton St., New York.

Engineers, Mechanical.

William M. Brewer, Vancouver, B. C.
Geo. M. Brill, Marquette Bldg., Chicago, Ill.
Edward S. Cobb., Los Angeles, Cal.
Engineering Co. of America, 74 B'way, New York.
Hugo Diemer, Lawrence, Kans.
Robt. McF. Doble, 314 Hayward Bldg., San Francisco, Cal.
Alfred G. Heggem, Massillon, Ohio.
Holt & Schober, 378 Bourse, Philadelphia, Pa.
Julian Kennedy, Pittsburg, Pa.
Walter Kennedy, Pittsburg, Pa.
G. W. McClure, Son & Co., Pittsburg, Pa.
Milton L. Oglesby, David Keith Bldg., Salt Lake City, Utah.
W. K. Palmer, 401 N. Y. Life Bldg., Kansas City, Mo.
C. L. Redfield, 1563 Monadnock Block, Chicago, Ill.
Sydney F. Reynolds, Torrey, Pa.
A. W. Robinson, Montreal, Canada.
H. B. Roelker, 41 Maiden Lane, New York.
Chas. S. Sage, Wellsville, N. Y.
Philip K. Stern, 130 Fulton St., New York.
David Townsend, 624 Witherspoon Bldg., Phila., Pa.

Engineers, Mining.

William M. Brewer, Vancouver, B. C.
Chas. Catlett, Staunton, Va.
L. B. Darling, Providence, R. I.
Engineering Co. of America, 74 B'way, New York.
Henshaw, Bulkley & Co., San Francisco, Cal.
Bernard MacDonald, Spokane, Wash.
Milton L. Oglesby, David Keith Bldg., Salt Lake City, Utah.
Sydney F. Reynolds, Torrey, Pa.

Engines, Blowing.

Allis-Chalmers Co., Chicago, Ill.
American Blower Co., Detroit, Mich.
Sprague Electric Co., 527 W. 34th St., New York.
Southwark Foundry & Machine Co., Phila., Pa.
Wm. Tod Co., Youngstown, O.

Engines—Gas, Gasoline, and Petroleum.

American Well Works, Aurora, Ill.
Aultman Company, Canton, Ohio.
Borden & Selleck Co., Chicago, Ill.
General Power Co., 81-83 Fulton St., New York.
Hercules Gas Engine Works, 217 Bay St., San Francisco, Cal.
J. D. Lyon & Co., Pittsburg, Pa.
Machinery & Electrical Co., Los Angeles, Cal.
August Mietz, 128 Mott St., New York.
Northern Engineering Works, Detroit, Mich.
Struthers-Wells Company, Warren, Pa.
Weber Gas & Gasoline Engine Co., Kansas City, Mo.
Westinghouse Machine Co., Pittsburg, Pa.
Westinghouse, Church, Kerr & Co., 26 Cortlandt St., New York.

Engines, Marine.

August Mietz, 128 Mott St., New York.

Engines, Steam.

Allis-Chalmers Co., Chicago, Ill.
American Blower Co., Detroit, Mich.
American Engine Co., Bound Brook, N. J
American Well Works, Aurora, Ill.
Atlas Engine Co., Indianapolis, Ind.
Aultman Company, Canton, Ohio.
Ball Engine Co., Erie, Pa.
Ball & Wood Co., 17 Battery Place, New York.
A. F. Bartlett & Co., Saginaw, Mich.
Bradley Mfg. Co., Allegheny, Pa.
Brown Corliss Engine Co., Corliss, Wis.
Contractors' Supply & Equipment Co., Chicago, Ill.
Erie Pump & Engine Co., Erie, Pa.
Frick Company, Waynesboro, Pa.
Harrisburg Foundry & Machine Co., Harrisburg, Pa.
Harron, Rickard & McCone, 21 Fremont St., San Francisco, Cal.
Hooven, Owens, Rentschler Co., Hamilton, Ohio.
S. W. Luitwieler Co., Los Angeles, Cal.
P. B. McCabe & Co., 602 No. Main St., Los Angeles, Cal.
Minneapolis Steel & Machinery Co., Minneapolis, Minn.
Providence Engineering Works, Providence, R. I.
Quincy Engine Works, Quincy, Ill.
Reeves Engine Co., 85 Liberty St., New York.
Rider-Ericsson Engine Co., New York City.
Rotary Engine Co., Philadelphia, Pa.
Shepherd Engineering Co., Franklin, Pa.
Skinner Engine Co., Erie, Pa.
Southwark Foundry & Machine Co., Phila., Pa.
Struthers-Wells Company, Warren, Pa.
B. F. Sturtevant Co., Jamaica Plain Station, Boston, Mass.
The William Tod Co., Youngstown, Ohio.
Vulcan Iron Works, San Francisco, Cal.
Webster, Camp & Lane Machine Co., Cleveland, O.
Willamette Iron & Steel Co., Portland, Ore.
Robt. Wetherill & Co., Chester, Pa.
Westinghouse Machine Co., Pittsburg, Pa.
Westinghouse, Church, Kerr & Co., 26 Cortlandt St., New York.

Evaporators.

Wheeler Condenser & Engineering Co., 120 Liberty St., New York.

Excavators.

Atlantic, Gulf & Pacific Co., Park Row Bldg., N. Y.
Broderick & Bascom Rope Co., St. Louis, Mo.

Bucyrus Co., So. Milwaukee, Wis.
The Hayward Co., 97 Cedar St., New York.
Kingsford Fdy. & Mch. Works, Oswego, N. Y.
Jeffrey Mfg. Co., Columbus, Ohio.
A. Leschen & Sons Rope Co., St. Louis, Mo.
Marion Steam Shovel Co., Marion, Ohio.
Robins Conveying Belt Co., 14-22 Park Row, N. Y.
Vulcan Iron Works, Toledo, Ohio.

Exhaust Heads.

Direct Separator Co., Syracuse, N. Y.
A. A. Griffing Iron Co., 66-68 Centre St., New York; Works, Jersey City.
Hoppes Mfg. Co., Springfield, Ohio.
B. F. Sturtevant Co., Jamaica Plain Station, Boston, Mass.
Watson & McDaniel Co., Philadelphia, Pa.
Wright Mfg. Co., Detroit, Mich.

Fans, Ventilating.

Allis-Chalmers Co., Chicago, Ill.
American Blower Co., Detroit, Mich.
Harron, Rickard & McCone, San Francisco, Cal.
Power Specialty Co., 126 Liberty St., New York.
Sprague Electric Co., 527 W. 34th St., New York.
B. F. Sturtevant Co., Jamaica Plain Station, Boston, Mass.

Feed-Water Heaters and Purifiers.

Allis-Chalmers Co., Chicago, Ill.
G. M. Davis Regulator Co., 144 Milwaukee Ave., Chicago, Ill.
Goubert Mfg. Co., 85 Liberty St., New York.
Green Fuel Economizer Co., Matteawan, N. Y.
A. A. Griffing Iron Co., 66-68 Centre St., New York; Works, Jersey City.
Harron, Rickard & McCone, San Francisco, Cal.
Harrison Safety Boiler Works, 3138 N. 17th St., Philadelphia, Pa.
Hoppes Manufacturing Co., Springfield, Ohio.
John H. McGowan Co., Cincinnati, Ohio.
National Pipe Bending Co., New Haven, Conn.
Providence Engineering Works, Providence, R. I.
Ross Valve Co., Troy, N. Y.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.
Stewart Heater Co., Buffalo, N. Y.
Warren Webster & Co., Camden, N. J.
Robt. Wetherill & Co., Chester, Pa.
Wheeler Condenser & Engineering Co., 120 Liberty St., New York.

Fertilizer Machinery.

Aultman Company, Canton, Ohio.
Jeffrey Mfg. Co., Columbus, Ohio.
Link-Belt Eng'g Co., Nicetown, Philadelphia, Pa.
E. H. Stroud & Co., Chicago, Ill.

Files and Rasps.

G. & H. Barnett Co., Philadelphia, Pa.
Nicholson File Co., Providence, R. I.

Filters.

L. O. Koven & Bro., New York City.
New York Cont. Jewell Filt. Co., 15 Broad St., N. Y.
Ross Valve Co., Troy, N. Y.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.
Robt. Wetherill & Co., Chester, Pa.

Fire Brick.

Henry Maurer & Son, 420 East 23d St., New York.
S. Obermayer Co., Cincinnati, Ohio.

Fireproof Building Materials.

Henry Maurer & Son, 420 East 23d St., New York.
National Fireproofing Co., Pittsburg, Pa.
Roebling Construction Co., 121 Liberty St., N. Y.

Filing Cabinets.

American Drafting Furniture Co., Rochester, N. Y.

Flanges.

E. M. Dart Mfg. Co., 136 Clifford St., Providence, R. I.
Jefferson Mfg. Co., Lexington, Mass.
Latrobe Steel Co., 1200 Girard Bldg., Phila., Pa.

Flanges (Weldless Steel).

Latrobe Steel Co., 1200 Girard Bldg., Phila., Pa.

Flexible Shafts.

Stow Flexible Shaft Co., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.

Floor and Sidewalk Lights.

F. H. Brooks & Co., Cleveland, Ohio.

Flooring, Factory.

American Lumber & Mfg. Co., Pittsburg, Pa.
U. S. Wood Preserving Co., 29 B'way, New York.

Flour Tallies.

W. N. Durant Co., 235 22d St., Milwaukee, Wis.

Flue Scrapers.

Eagle Oil & Supply Co., 104 Broad St., Boston, Mass.
Wm. B. Pierce Co., Buffalo, N. Y.

Fly Wheels.

Allis-Chalmers Co., Chicago, Ill.
Poole Engineering & Machine Co., Baltimore, Md.
Quincy Engine Works, Quincy, Ill.
S. Morgan Smith Co., York, Pa.
Robt. Wetherill & Co., Chester, Pa.

Forges.

B. F. Sturtevant Co., Jamaica Plain Station, Boston, Mass.

Forging Machinery.

Scranton & Co., 39 Church St., New Haven, Conn.

Forgings, Iron and Steel.

Chester B. Albree, Allegheny, Pa.
Keystone Drop Forge Works, Philadelphia, Pa.
Maryland Steel Co., Sparrows Point, Md.
E. M. Shaw, Providence, R. I.
Pennsylvania Steel Co., Steelton, Pa.
Wyman & Gordon, Worcester, Mass.

Foundry Equipment.

Blanchard Machine Co., Boston, Mass.
Buffalo Foundry Co., Buffalo, N. Y.
Diamond Drill & Machine Co., Birdsboro, Pa.
A. Garrison Foundry Co., Pittsburg, Pa.
C. W. Hunt Co., West New Brighton, N. Y.
Arthur Koppel, 68 Broad St., New York.
Northern Engineering Works, Detroit, Mich.
S. Obermayer Co., Cincinnati, Ohio.
Pedrick & Ayer Co., Philadelphia, Pa.
Shaw Electric Crane Co., Muskegon, Mich.
F. B. Stevens, Detroit, Mich.

Friction Clutches.

American Tool & Machine Co., Boston, Mass.
H. W. Caldwell & Sons Co., Chicago, Ill.
Case Mfg. Co., Columbus, Ohio.
Dodge Mfg. Co., Mishawaka, Ind.
Link-Belt Eng'g Co., Nicetown, Philadelphia, Pa.
Poole Engineering & Machine Co., Baltimore, Md.
S. Morgan Smith Co., York, Pa.

Fuel Economizers.

Green Fuel Economizer Co., Matteawan, N. Y.
Parson Mfg. Co., 320 Broadway, New York.
Providence Engineering Works, Providence, R. I.
Steam Boiler Equipment Co., 30 W. Houston St., New York.
E. H. Stroud & Co., Chicago, Ill.

Furnace Builders.

American Gas Furnace Co., 23 John St., New York.
Continental Iron Wks., West & Calver Sts., Brooklyn, N. Y.
Julian Kennedy, Pittsburg, Pa.
G. W. McClure, Son & Co., Smith Block, Pittsburg, Pa.
Morgan Construction Co., Worcester, Mass.
Parson Mfg. Co., 320 Broadway, New York.
Riter-Conley Mfg. Co., Pittsburg, Pa.
Waterbury Farrel Foundry & Machine Co., Waterbury, Conn.

Furnaces, Assayers.

F. W. Braun & Co., Los Angeles, Cal.

Gages—Pressure, Steam, Water, etc.

American Steam Gauge & Valve Co., Boston, Mass.
Ashcroft Mfg. Co., 85-89 Liberty St., New York.
Bristol Co., Waterbury, Conn.
Crosby Steam Gage & Valve Co., Boston, Mass.
Hohmann & Maurer Mfg. Co., Rochester, N. Y.
John Simmons Co., 110 Centre St., New York.
Standard Gauge Mfg. Co., Syracuse, N. Y.
Star Brass Mfg. Co., Boston, Mass.
Walworth Manufacturing Co., Boston, Mass.

Galvanizing.

L. O. Koven & Bro., New York City.
John Simmons Co., 110 Centre St., New York.

Galvanizing Machinery and Furnaces (Wire).

Turner, Vaughn & Taylor Co., Cuyahoga Falls, O.

Gas Holders and Regulators.

Continental Iron Wks., West & Calyer Sts., Brooklyn, N. Y.
Riter Conley Mfg. Co., Pittsburg, Pa.

Gaskets.

Boston Belting Co., Boston, Mass.
Eagle Oil & Supply Co., 104 Broad St., Boston, Mass.
U. S. Mineral Wool Co., 143 Liberty St., New York.

For Alphabetical Index to Advertisers see inside back cover.

s Machines and Generators.

merican Gas Furnace Co., 23 John St., New York.
nk-Belt Eng'g Co., Nicetown, Philadelphia, Pa.
omis-Pettibone Gas Mchy. Co., 52 William St., New York.
organ Construction Co., Worcester, Mass.
D. Wood & Co., Philadelphia, Pa.
alworth Manufacturing Co., Boston, Mass.

s Washer.

oman Co., Pittsburg, Pa.

ar Cutting Machines.

cker-Brainard Milling Machine Co., Hyde Park, Mass.
ould & Eberhardt, Newark, N. J.

aring.

llis-Chalmers Co., Chicago, Ill.
ugo Bilgram, 440 No. 12th St., Philadelphia, Pa.
oston Gear Works, Boston, Mass.
eo. F. Blake Mfg. Co., 91 Liberty St., New York.
rown & Sharpe Mfg. Co., Providence, R. I.
ahl Malleable Co., Detroit, Mich.
W. Caldwell & Son Co., Chicago, Ill.
ase Mfg. Co., Columbus, Ohio.
ayton Globe Iron Works Co., Dayton, O.
odge Mfg. Co., Mishawaka, Ind.
ould & Eberhardt, Newark, N. J.
ffrey Mfg. Co., Columbus, Ohio.
nowles Steam Pump Wks., 91 Liberty St., N. Y.
orse Elevator Works, Philadelphia, Pa.
ew Process Rawhide Co., Syracuse, N. Y.
D. Nuttall Co., Pittsburg, Pa.
oole Engineering & Machine Co., Baltimore, Md.
illiam Sellers & Co., Inc., Philadelphia, Pa.
tow Flexible Shaft Co., Philadelphia, Pa.
obt. Wetherill & Co., Chester, Pa.

ain Elevator Machinery.

llis Chalmers Co., Chicago, Ill.
ultman Co., Canton, Ohio.
odge Mfg. Co., Mishawaka, Ind.
ffrey Mfg. Co., Columbus, Ohio.
ink-Belt Eng'g Co., Nicetown, Philadelphia, Pa.
iter Conley Mfg. Co., Pittsburg, Pa.
obins Conveying Belt Co., 14-22 Park Row, N. Y.

aphite.

os. Dixon Crucible Co., Jersey City, N. J.
he S. Obermayer Co., Cincinnati, Ohio.

inders, Electric.

orthern Electrical Mfg. Co., Madison, Wis.

inding and Polishing Machinery.

rown & Sharpe Mfg. Co., Providence, R. I.
iamond Machine Co., Providence, R. I.
odge Mfg. Co. Mishawaka, Ind.
arron, Rickard & McCone, San Francisco, Cal.
isey-Wolf Machine Co., Cincinnati, Ohio.
andis Tool Co., Waynesboro, Pa.
iles-Bement-Pond Co., 136 Liberty St., New York.
ratt & Whitney Co., Hartford, Conn.
m. Sellers & Co., Inc., Philadelphia, Pa.
L. Smidth & Co., 63 Maiden Lane, New York.
tow Flexible Shaft Co., Philadelphia, Pa.

angers —SEE PULLEYS.

eading and Upsetting Machines.

ational Machinery Co., Tiffin, Ohio.

eating and Ventilating Apparatus.

merican Blower Co., Detroit, Mich.
A. A. Griffing Iron Co., 66-68 Centre St., New York; Works, Jersey City.
ayden & Derby Mfg. Co., New York.
ohn Simmons Co., 110 Centre St., New York.
prague Electric Co., 527 W. 34th St., New York.
H. B. Smith Co., 137 Centre St., New York.
B. F. Sturtevant Co., Jamaica Plain Station, Boston, Mass.
Walworth Mfg. Co., Boston, Mass.

oisting Engines and Machinery.

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Contractors' Supply & Equipment Co., Chicago, Ill.
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Providence Engineering Works, Providence, R. I.
Quincy Engine Works, Quincy, Ill.
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Webster, Camp & Lane Machine Co., Cleveland, O.
Weber Gas & Gasoline Engine Co., Kansas City, Mo.

Hollow Chisel Mortisers.

J. A. Fay & Egan Co., 212-232 West Front St., Cincinnati, Ohio.

Hose.

Boston Belting Co., Boston, Mass.
Eagle Oil & Supply Co., 104 Broad St., Boston, Mass.
Eureka Fire Hose Co., New York City.

Hydraulic Machinery.

Detroit Leather Specialty Co., Detroit, Mich.
Harron, Rickard & McCone, San Francisco, Cal.
John H. McGowan Co., Cincinnati, Ohio.
S. Morgan Smith Co., York, Pa.
Niles-Bement-Pond Co., 136 Liberty St., New York.
Pelton Water Wheel Co., San Francisco, Cal.
Poole Engineering & Machine Co., Baltimore, Md.
Power Specialty Co., 126 Liberty St., New York.
Waterbury Farrel Foundry & Machine Co., Waterbury, Conn.
Watson-Stillman Co., 210 E. 43d St., New York.
R. D. Wood & Co., Philadelphia, Pa.

Hydraulic Rams.

Pelton Water Wheel Co., San Francisco, Cal.
Power Specialty Co., 126 Liberty St. New York.

Ice-Making and Refrigerating Machinery.

Geo. F. Blake Mfg. Co., 114 Liberty St., New York.
Deane Steam Pump Co. of Holyoke, 116 Liberty St., New York.
Frick Company, Waynesboro, Pa.
Knowles Steam Pump Wks., 114 Liberty St., N. Y.
Laidlaw-Dunn-Gordon Co., 116 Liberty St., N. Y.
Penna. Iron Wks. Co., 50th St. & Lancaster Ave., Philadelphia, Pa.
H. B. Roelker, 41 Maiden Lane, New York.
Snow Steam Pump Works, 116 Liberty St., N. Y.
Vulcan Iron Works, San Francisco, Cal.
Westinghouse Machine Co., Pittsburg, Pa.
Westinghouse, Church, Kerr & Co., 26 Cortlandt St., New York.
Henry R. Worthington, 118 Liberty St., New York.

Injectors.

Hayden & Derby Mfg. Co., New York.
The Lunkenheimer Co., Cincinnati, Ohio.
John Simmons Co., 110 Centre St., New York.
Wm. Sellers & Co., Philadelphia, Pa.

Insulated Wire.

General Electric Co., New York.
Sprague Electric Co., 527 W. 34th St., New York.

Insulating Materials.

Sterling Varnish Co., Pittsburg, Pa.

Internal Gearing.

R. D. Nuttall Co., Pittsburg, Pa.

Jacks.
Atlas Railway Supply Co., Manhattan Bldg., Chicago, Ill.

Jacks, Hydraulic.
Watson-Stillman Co., New York City.

Jet Apparatus.
Hayden & Derby Mfg. Co., New York.

Kiers.
Atlantic Works, East Boston, Mass.

Laboratory Supplies.
F. W. Braun & Co., Los Angeles, Cal.

Lamps, Electric.
General Electric Co., New York.
Sterling Electrical Mfg. Co., Warren, Ohio.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Lathes.
American Tool & Machine Co., Boston, Mass.
W. F. & John Barnes Co., Rockford, Ill.
Bullard Machine Tool Co., Bridgeport, Conn.
Diamond Machine Co., Providence, R. I.
Fay & Scott, Dexter, Me.
A. Garrison Foundry Co., Pittsburg, Pa.
Jones & Lamson Machine Co., Springfield, Vt.
Miami Valley Machine Tool Co., Dayton, O.
Niles-Bement-Pond Co., 136 Liberty St., New York.
Pond Machine Tool Co., Plainfield, N. J.
Pratt & Whitney Co., Hartford, Conn.
Wm. Sellers & Co., Inc., Philadelphia, Pa.
Waterbury Farrel Foundry & Machine Co., Waterbury, Conn.

Leather, Hydraulic, Valve and Pump.
Detroit Leather Specialty Co., Detroit, Mich.
Chas. A. Schieren & Co., 45-51 Ferry St., New York.

Light Railways.
C. W. Hunt Co., West New Brighton, New York.
Arthur Koppel, 68 Broad St., New York.
Link-Belt Eng'g Co., Nicetown, Philadelphia, Pa.
John A. Mead Mfg. Co., 11 Broadway, New York.
G. L. Stuebner, Long Island City, N. Y.

Lockers.
Merritt & Co., Philadelphia, Pa.

Locomotive Cranes.
Browning Engineering Co., Cleveland, Ohio.
Industrial Works, Bay City, Mich.

Locomotives, Compressed Air.
Baldwin Locomotive Works, Phila, Pa.
H. K. Porter Co., Pittsburg, Pa.

Locomotives, Electric.
Baldwin Locomotive Works, Philadelphia, Pa.
Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., New York.
C. W. Hunt Co., West New Brighton, N. Y.
Jeffrey Mfg. Co., Columbus, Ohio.
Arthur Koppel, 68 Broad St., New York.
H. K. Porter Co., Pittsburg, Pa.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Locomotives, Steam.
American Locomotive Co., 25 Broad St., New York.
Baldwin Locomotive Works, Philadelphia, Pa.
Contractors' Supply & Equipment Co., Chicago, Ill.
Lima Locomotive & Machine Co., Lima, Ohio.
H. K. Porter Co., Pittsburg, Pa.
Rogers Locomotive Works, Paterson, N. J.

Loose Leaf Files.
Tengwall File & Ledger Co., Chicago, Ill.

Loose Leaf Ledgers.
Tengwall File & Ledger Co., Chicago, Ill.

Lubricants.
Jos. Dixon Crucible Co., Jersey City, N. J.
Eagle Oil & Supply Co., 104 Broad St., Boston, Mass.

Lubricating and Oiling Devices.
E. M. Dart Mfg. Co., 136 Clifford St., Providence, R. I.
Harron, Rickard & McCone, San Francisco, Cal.

Machinery Exhibit.
Bourse, Philadelphia, Pa.

Machine Shop Furniture.
Lyon Metallic Mfg. Co., 18 S. Ann St., Chicago

Machinists' Small Tools.
Brown & Sharpe Mfg. Co., Providence, R. I.
Thomas H. Dallett Co., York St. & Sedgley Philadelphia, Pa.
Morse Twist Drill & Mch. Co., New Bedford,
Pratt & Whitney Co., Hartford, Conn.
Wm. Sellers & Co., Inc., Philadelphia, Pa.
Standard Tool Co., Cleveland, Ohio.

Manufacturers' Export Representative.
M. Gradstone & Co., 2-4 Stone St., New York.

Metal Polish.
Eagle Oil & Supply Co., 104 Broad St., Bos Mass.

Meters, Electric.
General Electric Co., New York.
Westinghouse Electric & Mfg. Co., Pittsburg.
Weston Elec. Inst. Co., Waverly Pk., Essex Co.,

Milling Machines.
Adams Company, Dubuque, Iowa.
American Tool & Machine Co., Boston, Mass.
Becker-Brainard Milling Machine Co., Hyde P Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Harron, Rickard & McCone, 21 Fremont St., Francisco, Cal.
Hendrie & Bolthoff Mfg. & Supply Co., Denver, C
Henshaw, Bulkley & Co., San Francisco, Cal.
Hess Machine Co., 15th and Chestnut Sts., Ph delphia, Pa.
Niles-Bement-Pond Co., 136 Liberty St., New Y
Pratt & Whitney Co., Hartford, Conn.

Milling Tools.
Harron, Rickard & McCone, 21 Fremont St., Francisco, Cal.

Mill Supplies.
Eagle Oil & Supply Co., 104 Broad St., Bos Mass.
Harron, Rickard & McCone, San Francisco, Cal.
Phillips Mine & Mill Supply Co., Pittsburg, Pa

Mine Cars.
Allis-Chalmers Co., Chicago.
C. W. Hunt Co., West New Brighton, N. Y.
Engineering Works of Wonham-Magor, 29 Br way, New York.
Jeffrey Manufacturing Co., Columbus, Ohio.
Kilbourne & Jacobs Mfg. Co., Columbus, O.
Arthur Koppel, 68 Broad St., New York.
Lima Locomotive and Machine Co., Lima, O.
Watt Mining Car Wheel Co., Barnesville, Ohio.

Mining Machinery.
Allis-Chalmers Co., Chicago, Ill.
American Diamond Rock Drill Co., 95 Liberty New York.
A. F. Bartlett & Co., Saginaw, Mich.
Geo. F. Blake Mfg. Co., 114 Liberty St., New Y
Broderick & Bascom Rope Co., St. Louis, Mo.
Buhl Malleable Co., Detroit, Mich.
A. S. Cameron Steam Pump Wks., E. 23d St., N
Card & Weber Machine Co., Denver, Colo.
Contractors' Supply & Equipment Co., Chicago,
Davis Calyx Drill Co., 128 Broadway, New Yor
Deane Steam Pump Co. of Holyoke, 116 Lib St., New York.
Diamond Drill & Machine Co., Birdsboro, Pa.
General Electric Co., New York.
Harron, Rickard & McCone, 21 Fremont St., Francisco, Cal.
Hendrie & Bolthoff Mfg. & Supply Co., Denver, C
Henshaw, Bulkley & Co., San Francisco, Cal.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N.
Jeffrey Mfg. Co., Columbus, Ohio.
Knowles Steam Pump Wks., 114 Liberty St., N.
Arthur Koppel, 68 Broad St., New York.
Laidlaw-Dunn-Gordon Co., 116 Liberty St., N.
Lambert Hoisting Engine Co., Newark, N. J.
A. Leschen & Sons Rope Co., St. Louis, Mo.
Lidgerwood Mfg. Co., 96 Liberty St., New Yor
The Machinery & Electrical Co., Los Angeles, C
Marion Steam Shovel Co., Marion, Ohio.
John H. McGowan Co., Cincinnati, Ohio.
Norwalk Iron Works, South Norwalk, Conn.
Phillips Mine & Mill Supply Co., Pittsburg, Pa.
Power Specialty Co., 126 Liberty St., New Yor
Providence Engineering Works, Providence, R.
Quincy Engine Works, Quincy, Ill.
Rand Drill Co., 128 Broadway, New York.
Robins Conveying Belt Co., 14-22 Park Row, N.

F. L. Smidth & Co., 66 Maiden Lane, New York.
Snow Steam Pump Works, 116 Liberty St., N. Y.
E. H. Stroud & Co., Chicago, Ill.
Trenton Iron Works Co., Trenton, N. J.
Vulcan Iron Works, San Francisco, Cal.
Vulcan Iron Works Co., Toledo, Ohio.
Watt Mining Car Wheel Co., Barnesville, Ohio.
Webster, Camp & Lane Machine Co., Cleveland, O.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.
Henry R. Worthington, 118 Liberty St., New York.

Mining Screens—SEE SCREENS.

Motors, Electric.

American Engine Co., Bound Brook, N. J.
Bullock Electric Mfg. Co., Cincinnati, Ohio.
C & C Electric Co., 145 Liberty St., New York.
Christensen Engineering Co., Milwaukee, Wis.
Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Guarantee Electric Co., Chicago, Ill.
Jantz & Leist Electric Co., Cincinnati, Ohio.
Jeffrey Mfg. Co., Columbus, Ohio.
National Electric Co., Milwaukee, Wis.
Northern Electrical Mfg. Co., Madison, Wis.
The Robbins & Myers Co., Springfield, Ohio.
Sprague Electric Co., 527 W. 34th St., New York.
Stow Mfg. Co., Binghamton, N. Y.
B. F. Sturtevant Co., Jamaica Plain Station, Boston, Mass.
Triumph Electric Co., Cincinnati, Ohio.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Moulding Machines.

Frank Machinery Co., Buffalo, N. Y.
S. Obermayer Co., Cincinnati, Ohio.
Pa.
Power Specialty Co., 126 Liberty St., New York.
Tabor Mfg. Co., Philadelphia, Pa.
Turner Machine Co., Philadelphia, Pa.

Muffles and Annealing Furnaces (Wire).

Turner, Vaughn & Taylor Co., Cuyahoga Falls, O.

Naphtha Gas Machines.

American Gas Furnace Co., 23 John St., New York.

Nickel.

Benedict & Burnham Mfg. Co., Waterbury, Conn.
Orford Copper Co., 74 Broadway, New York.

Nozzle and Sleeve Press.

Turner, Vaughn & Taylor Co., Cuyahoga Falls, O.

Nut Tappers.

National Machinery Co., Tiffin, Ohio.

Oak Timbers.

American Lumber & Mfg. Co., Pittsburg, Pa.

Office Equipment.

Globe-Wernicke Co., Cincinnati, Ohio.

Oil Burners.

C. A. Hummel, 120 W. Fifth St., Los Angeles, Cal.

Oil Filters.

Eagle Oil & Supply Co., 104 Broad St., Boston, Mass.
Pittsburg Gage & Supply Co., Pittsburg, Pa.

Oil Separators.

Austin Separator Co., Detroit, Mich.
Griffing Iron Co., Jersey City, N. J.
Harrison Safety Boiler Works, 3138 No. Seventeenth St., Philadelphia, Pa.

Open Hearth Furnaces.

G. W. McClure, Son & Co., Smith Block, Pittsburg, Pa.

Ore-Roasting Machinery.

Allis-Chalmers Co., Chicago, Ill.

Packing.

Boston Belting Co., Boston, Mass.
Broderick & Bascom Rope Co., St. Louis, Mo.
Detroit Leather Specialty Co., Detroit, Mich.
Eagle Oil & Supply Co., 104 Broad St., Boston, Mass.
Hileman-James Co., 523 Locust St., McKeesport, Pa.
Jenkins Brothers, 71 John St., New York.
A. Leschen & Sons Rope Co., St. Louis, Mo.
Mabbs Hydraulic Packing Co., Board of Trade, Chicago, Ill.

Paints and Varnishes.

Atlas Railway Supply Co., Chicago, Ill.
Detroit Graphite Mfg. Co., Detroit, Mich.
Joseph Dixon Crucible Co., Jersey City, N. J.
Garry Iron & Steel Co., Cleveland, Ohio.
Paraffine Paint Co., San Francisco, Cal.
Standard Paint Co., 100 William St., New York.
Sterling Varnish Co., Pittsburg, Pa.

Paper-Mill Machinery.

Aultman Company, Canton, Ohio.
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Deane Steam Pump Co. of Holyoke, 116 Liberty St., New York.
Dodge Mfg. Co., Mishawaka, Ind.
Jeffrey Mfg. Co., Columbus, Ohio.
Knowles Steam Pump Wks., 114 Liberty St., N. Y.
Laidlaw-Dunn-Gordon Co., 116 Liberty St., N. Y.
Robins Conveying Belt Co., 14-22 Park Row, N. Y.
Snow Steam Pump Works, 116 Liberty St., N. Y.
Henry R. Worthington, 118 Liberty St., New York.

Patent Attorneys.

C. A. Dieterich, 257 Broadway, New York.
Evans, Wilkins & Co., Evans Building, Washington, D. C.
Philip K. Stern, 130 Fulton St., New York.

Pattern-Makers' Machinery.

J. A. Fay & Egan Co., 212-232 West Front St., Cincinnati, Ohio.
Fay & Scott, Dexter, Me.
Pratt & Whitney Co., Hartford, Conn.

Pattern Makers.

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Diamond Drill & Machine Co., Birdsboro, Pa.

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Robt. Aitchison Perforated Metal Co., Chicago, Ill.
Allis-Chalmers Co., Chicago, Ill.
H. W. Caldwell & Sons Co., Chicago, Ill.
Turner, Vaughn & Taylor Co., Cuyahoga Falls, O.

Phosphor Bronze.

Phosphor Bronze Smelting Co., Ltd., Phila., Pa.
Poole Engineering & Machine Co., Baltimore, Md.
Paul S. Reeves & Son., Philadelphia, Pa.

Pile Drivers.

Vulcan Iron Works, Chicago, Ill.

Pinions.

A. Garrison Foundry Co., Pittsburg, Pa.

Pipe.

American Spiral Pipe Works, Chicago, Ill.
Garry Iron & Steel Co., Cleveland, Ohio.
L. O. Koven & Bro., 50 Cliff St., New York.
McNab & Harlin Mfg. Co., 56-60 John St., N. Y.
Nason Mfg. Co., 71 Fulton St., New York.
National Pipe Bending Co., New Haven, Conn.
Pelton Water Wheel Co., San Francisco, Cal.
The Michigan Pipe Co., Bay City, Mich.
U. S. Cast Iron Pipe & Fdy. Co., Philadelphia, Pa.
U. S. Wind Engine & Pump Co., Batavia, Ill.

Pipe-Cutting and Threading Machines.

Bignall & Keeler Mfg. Co., Edwardsville, Ill.
Cox & Sons Company, Bridgeton, N. J.
Harron, Rickard & McCone, San Francisco, Cal.
Niles-Bement-Pond Co., 136 Liberty St., New York.
Pratt & Whitney Co., Hartford, Conn.
John Simmons Co., 110 Centre St., New York.
Walworth Manufacturing Co., Boston, Mass.

Pipe Fittings, Cast-Iron.

Kelly & Jones Co., Greensburg, Pa.
McNab & Harlin Mfg. Co., 56-60 John St., N. Y.
Pelton Water Wheel Co., San Francisco, Cal.
John Simmons Co., 110 Centre St., New York.
Walworth Manufacturing Co., Boston, Mass.
U. S. Wind Engine & Pump Co., Batavia, Ill.

Pipe Vises.

John Simmons Co., 110 Centre St., New York.

Planers.

Cleveland Punch & Shear Works, Cleveland, Ohio.
Frank Machinery Co., Buffalo, N. Y.
Hilles & Jones Co., Wilmington, Del.
Niles-Bement-Pond Co., 136 Liberty St., New York.
Pratt & Whitney Co., Hartford, Conn.
Wm. Sellers & Co., Inc., Philadelphia, Pa.
Whitcomb Mfg. Co., Worcester, Mass.

Planing Mill Machinery.

J. A. Fay & Egan Co., 212-232 West Front St., Cincinnati, Ohio.
Harron, Rickard & McCone, San Francisco, Cal.

Platinum Ware.

F. W. Braun Co., Los Angeles, Cal.

Pneumatic Tools.

Chicago Pneumatic Tool Co., Chicago, Ill.
Clayton Air Compress. Wks., 114 Liberty St., N. Y.
Cleveland Pneumatic Tool Co., Cleveland, Ohio
Curtis & Co. Mfg. Co., St. Louis, Mo.
Thos. H. Dallett & Co., Philadelphia, Pa.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
E. W. Irwin Machinery & Supply Co., 114 Liberty St., New York.
Pedrick & Ayer Co., Philadelphia, Pa.
Philadelphia Pneumatic Tool Co., Philadelphia, Pa.
Rand Drill Co., 128 Broadway, New York.
Standard Railway Equipment Co., St. Louis, Mo.

Pop Safety Valves.

Consolidated Safety Valve Co., 85-89 Liberty St., New York.
Star Brass Mfg. Co., Boston, Mass.

Portable Drilling Machines.

Hisey-Wolf Machine Co., Cincinnati, Ohio.
Thos. H. Dallett & Co., Philadelphia, Pa.

Power Hammers.

Pratt & Whitney Co., Hartford, Conn.
Scranton & Co., 39 Church St., New Haven, Conn.
Wm. Sellers & Co., Inc., Philadelphia, Pa.

Power-Transmission Machinery.

Allis-Chalmers Co., Chicago, Ill.
Aultman Company, Canton, Ohio.
Broderick & Bascom Rope Co., St. Louis, Mo.
Buhl Malleable Co., Detroit, Mich.
H. W. Caldwell & Sons Co., Chicago, Ill.
Case Mfg. Co., Columbus, Ohio.
Dayton Globe Iron Works Co., Dayton, O.
General Electric Co., New York.
Hayward Co., 97 Cedar St., New York
Jeffrey Mfg. Co., Columbus, Ohio.
Keasey Pulley Co., Toledo, O.
A. Leschen & Sons Rope Co., St. Louis, Mo.
Link Belt Eng'g Co., Nicetown, Philadelphia, Pa.
Niles-Bement-Pond Co., 136 Liberty St., New York.
Northern Electrical Mfg. Co., Madison, Wis.
Quincy Engine Works, Quincy, Ill.
Robins Conveying Belt Co., 14-22 Park Row, N. Y.
S. Morgan Smith Co., York, Pa.
Sprague Electric Co., 527 W. 34th St., New York.
Triumph Electric Co., Cincinnati, Ohio.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.
R. D. Wood & Co., Philadelphia, Pa.

Presses and Dies.

The Curtis & Curtis Co., Bridgeport, Conn.
Niagara Machine & Tool Works, Buffalo, N. Y.
Niles-Bement-Pond Co., 136 Liberty St., New York.
Pratt & Whitney Co., Hartford, Conn.
Waterbury Farrel Foundry & Machine Co., Waterbury, Conn.
Watson-Stillman Co., 210 E. 43d St., New York.
R. D. Wood & Co., Philadelphia, Pa.

Pressure Regulators—Steam, Water and Air.

Julian D'Este Company, 24 Canal St., Boston, Mass.
Richard Thompson & Co., 126 Liberty St., New York.

Prospecting Drills.

American Diamond Rock Drill Co., 95 Liberty St., New York.
American Well Works, Aurora, Ill.
Davis Calyx Drill Co., 128 Broadway, New York.

Pulleys, Shafting and Hangers.

Allis-Chalmers Co., Chicago, Ill.
American Tool & Machine Co., Boston, Mass.
Aultman Company, Canton, Ohio
H. W. Caldwell & Sons Co., Chicago, Ill.
Case Mfg. Co., Columbus, Ohio.
Cumberland Steel Co., Cumberland, Md.
Fay & Egan, 212-232 W. Front St., Cincinnat
Frank Machinery Co., Buffalo, N. Y.
Jeffrey Mfg. Co., Columbus, Ohio.
Keasey Pulley Co., Toledo, Ohio.
Niles Tool Works Co., New York, N. Y.
Poole Engineering & Machine Co., Baltimore,
Robins Conveying Belt Co., 14-22 Park Row,
Wm. Sellers & Co., Philadelphia, Pa.
S. Morgan Smith Co., York, Pa.

Pulverizers.

F. W. Braun Co., Los Angeles, Cal.
Harron, Rickard & McCone, 21 Fremont St., Francisco, Cal.
E. H. Stroud & Co., 30-36 La Salle St., Chicago

Pumps and Pumping Machinery.

Alberger Condenser Co., 95 Liberty St., New
Allis-Chalmers Co., Chicago, Ill.
American Well Works, Aurora, Ill.
Ashcroft Mfg. Co., 85-89 Liberty St., New Yo
Bacon Air Lift Co., 92 William St., New York.
Geo. F. Blake Mfg. Co., 114 Liberty St., New
Bucyrus Co., So. Milwaukee, Wis.
A. S. Cameron Steam Pump Wks., E. 23d St.,
Clayton Air Compress. Wks., 114 Liberty St.,
G. M. Davis Regulator Co., 144 Milwaukee Chicago, Ill.
The Deane Steam Pump Co. of Holyoke, 116 erty St., New York.
Epping-Carpenter Co., Pittsburg, Pa.
Flint & Walling Mfg. Co., Kendallville, Ind
General Power Co., 81-83 Fulton St., New Yor
Guild & Garrison, Brooklyn, N. Y.
Hall Steam Pump Co., Pittsburg, Pa.
Harron, Rickard & McCone, 21 Fremont St., Francisco, Cal.
Hercules Gas Engine Works, 217 Bay St., Francisco, Cal.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St.,
Kingsford Fdy. & Mch. Works, Oswego, N. Y.
Knowles Steam Pump Wks., 114 Liberty St.,
The Laidlaw-Dunn-Gordon Co., 116 Liberty New York
Machinery & Electrical Co., Los Angeles, Cal.
John H. McGowan Co., Cincinnati, Ohio
Morris Machine Works, Baldwinsville, N. Y.
Pneumatic Eng'g Co., 128 Broadway, N. Y.
Providence Engineering Works, Providence, R
Wm. E. Quimby, 86 Liberty St., New York.
Quincy Engine Works, Quincy, Ill.
Rider-Ericsson Eng. Co., 35 Warren St., New
Snow Steam Pump Works, 116 Liberty St., N.
Southwark Foundry & Machine Co., Phila., Pa.
William Tod Company, Youngstown, Ohio.
Watson-Stillman Co., New York City.
Webster, Camp & Lane Machine Co., Clevelan
Robt. Wetherill & Co., Chester, Pa.
Wheeler Condenser & Engineering Co., 120 Li St., New York.
R. D. Wood & Co., Philadelphia, Pa.
Henry R. Worthington, 118 Liberty St., New
U. S. Wind Engine & Pump Co., Batavia, Ill.

Pump Valves.

Boston Belting Co., Boston, Mass.
Power Specialty Co., 126 Liberty St., New Yor

Punches and Dies.

Globe Machine & Stamping Co., Cleveland, Ohi

Punching and Shearing Machinery.

Bethlehem Foundry & Mch. Co., So. Bethlehem,
Cleveland Punch & Shear Works, Cleveland,
Harron, Rickard & McCone, San Francisco, Cal
Hilles & Jones Co., Wilmington, Del.
A. Garrison Foundry Co., Pittsburg, Pa.
Morgan Construction Co., Worcester, Mass.
The National Machinery Co., Tiffin, O.
Niagara Machine & Tool Works, Buffalo, N. Y.
Niles-Bement-Pond Co., 136 Liberty St., New
Pond Machine Tool Co., Plainfield, N. J.
Pratt & Whitney Co., Hartford, Conn.
Wm. Sellers & Co., Inc., Philadelphia, Pa.
Waterbury Farrel Foundry & Machine Co., W bury, Conn.
R. D. Wood & Co., Philadelphia, Pa.

uarrying Machinery.
Broderick & Bascom Rope Co., St. Louis, Mo.
A. S. Cameron Steam Pump Wks., E. 23d St., N. Y.
Engineering Works of Wonham-Magor, 29 Broadway, New York.
Cooper. Hewitt & Co., 17 Burling Slip. New York
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
Lambert Hoisting Engine Co., Newark, N. J.
A. Leschen & Sons Rope Co., St. Louis, Mo.
Lidgerwood Mfg. Co., New York City.
John H. McGowan Co., Cincinnati, Ohio.
Rand Drill Co., 128 Broadway, New York.
Robins Conveying Belt Co., 14-22 Park Row, N. Y.
Trenton Iron Co., Trenton, N. J.
Vulcan Iron Works Co., Toledo, Ohio.

adiators.
A. A. Griffing Iron Co., 66-68 Centre St., New York: Works, Jersey City, N. J.
John Simmons Co., 110 Centre St., New York.
H. B. Smith Co., 137 Centre St., New York.

acks—Machine Cut.
R. D. Nuttall Co., Pittsburg, Pa.

ail Braces.
Atlas Railway Supply Co., Chicago, Ill.
Continuous Rail Joint Co. of Am., Century Bldg., Newark, N. J.
Wonham-Magor Eng'g Wks., 29 B'way, New York.

ail Joints.
Atlas Railway Supply Co., Chicago, Ill.
Continuous Rail Joint Co. of Am., Century Bldg., Newark, N. J.

ailway Shop Machinery.
Chester B. Albree, Allegheny, Pa.
W. F. & John Barnes Co., Rockford, Ill.
Bickford Drill & Tool Co., Cincinnati, Ohio.
J. A. Fay & Egan Co., 212-232 West Front St., Cincinnati, Ohio.
Hilles & Jones Co., Wilmington, Del.
Niles-Bement-Pond Co., 136 Liberty St., New York.
Norwalk Iron Works, South Norwalk, Conn.
Pedrick & Ayer Co., Philadelphia, Pa.
Pratt & Whitney Co., Hartford, Conn.
Stow Flexible Shaft Co., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.
Watson-Stillman Co., 210 E. 43d St., New York.

Railway Specialties.
Atlas Railway Supply Co., Chicago, Ill.
Continuous Rail Joint Co. of Am., Century Bldg., Newark, N. J.
Engineering Works of Wonham-Magor, 29 Broadway, New York.
C. W. Hunt Co., West New Brighton, N. Y.
Arthur Koppel, 68 Broad St., New York.
Maryland Steel Co., Sparrows Point, Md.
Jefferson Mfg. Co., Lexington, Mass.
John A. Mead Mfg. Co., New York City.
Pennsylvania Steel Co., Steelton, Pa.
H. K. Porter Co., Pittsburg, Pa.
Pratt & Whitney Co., Hartford, Conn.
Sprague Electric Co., 527 W. 34th St., New York.
Star Brass Mfg. Co., Boston, Mass.
Vulcan Iron Works Co., Toledo, Ohio.
Westinghouse Air Brake Co., Pittsburg, Pa.
U. S. Wind Engine & Pump Co., Batavia, Ill.

Reamers.
Standard Tool Co., Cleveland, Ohio.

Refrigerating Machinery—SEE ICE-MAKING MACHINERY.

Retort Coke Oven.
Kloman Co., Pittsburg, Pa.

Rheostats.
The Cutler-Hammer Mfg. Co., Milwaukee, Wis.
Simplex Electric Heating Co., Cambridgeport, Mass.

Riveting Machines.
Chester B. Albree, Allegheny, Pa.
Chicago Pneumatic Tool Co., Chicago, Ill.
Bethlehem Fdy. & Mch. Co., So. Bethlehem, Pa.
Thos. H. Dallett Co., Philadelphia, Pa.
Hilles & Jones Co., Wilmington, Del.
The National Machinery Co., Tiffin, O.
Niles-Bement-Pond Co., 136 Liberty St., New York.
Pedrick & Ayer Co., Philadelphia, Pa.
Philadelphia Pneumatic Tool Co., Philadelphia, Pa.
Rand Drill Co., 128 Broadway, New York.
Wm. Sellers & Co., Inc., Philadelphia, Pa.
R. D. Wood & Co., Philadelphia, Pa.

Rivet-Making Machinery.
National Machinery Co., Tiffin, O.

Road-Making Machinery.
Aultman Co., Canton, Ohio.
Vulcan Iron Works, Toledo, Ohio.

Rock Breakers.
Allis-Chalmers Co., Chicago, Ill.
Aultman Co., Canton, Ohio.
Harron, Rickard & McCone, San Francisco, Cal.
Robins Conveying Belt Co., 14-22 Park Row, N. Y.
F. L. Smidth & Co., 66 Maiden Lane, New York.
E. H. Stroud & Co., Chicago, Ill.
Sturtevant Mill Co., Boston, Mass.

Roofing.
Garry Iron & Steel Co., Cleveland, Ohio.
Paraffine Paint Co., San Francisco, Cal.
Standard Paint Co., 100 William St., New York

Rolling Mill Machinery.
Diamond Drill & Machine Co., Birdsboro, Pa.
A. Garrison Foundry Co., Pittsburg, Pa.
Kloman Co., Pittsburg, Pa.
Morgan Construction Co., Worcester, Mass.
Niles-Bement-Pond Co., 136 Liberty St., New York.
Poole Engineering & Machine Co., Baltimore, Md.
Quincy Engine Works, Quincy, Ill.
Robt. Wetherill & Co., Chester, Pa.

Rolls, Chill and Sand.
A. Garrison Foundry Co., Pittsburg, Pa.
Cleveland Punch & Shear Works, Cleveland, Ohio.

Roofing Paints and Varnish.
Paraffine Paint Co., San Francisco, Cal.
Standard Paint Co., 100 William St., New York.

Rope Transmission.
Aultman Company, Canton, Ohio.
Broderick & Bascom Rope Co., St. Louis, Mo.
H. W. Caldwell & Sons Co., Chicago, Ill.
Crocker-Wheeler Co., Ampere, N. J.
C. W. Hunt Co., West New Brighton, New York.
Jeffrey Mfg. Co., Columbus, Ohio.
A. Leschen & Sons Rope Co., St. Louis, Mo.
Link-Belt Eng'g Co., Nicetown, Philadelphia, Pa.
Providence Engineering Works, Providence, R. I.

Rubber Goods.
Boston Belting Co., Boston, Mass.
Jenkins Bros., 71 John St., New York.

Rubber Washing Machinery.
Turner, Vaughn & Taylor Co., Cuyahoga Falls, O.

Sand Mixers and Sifters.
The S. Obermayer Co., Cincinnati, Ohio.

Sand Pumps.
Card & Weber Machine Co., Denver, Colo.

Saw-Mill Machinery.
Allis-Chalmers Co., Chicago, Ill.
A. F. Bartlett & Co., Saginaw, Mich.
Curtis & Co. Mfg. Co., St. Louis, Mo.
J. A. Fay & Egan Co., 212-232 West Front St., Cincinnati, Ohio.
Harron, Rickard & McCone, 21 Fremont St., San Francisco, Cal.
Jeffrey Mfg. Co., Columbus, Ohio.
Vulcan Iron Works, San Francisco, Cal.

Saws.
Curtis & Co. Mfg. Co., St. Louis, Mo.

Scales and Balances.
Borden & Selleck Co., Chicago, Ill.
Wm. Ainsworth & Sons, Denver, Col.
F. W. Braun & Co., Los Angeles, Cal.

Screens, Mining.
Robert Aitchison Perforated Metal Co., Chicago, Ill.
Allis-Chalmers Co., Chicago, Ill.
Aultman Company, Canton, Ohio.
Henshaw, Bulkley Co., San Francisco, Cal.
Jeffrey Mfg. Co., Columbus, Ohio.
Robins Conveying Belt Co., 14-22 Park Row, N. Y.

Screw Machines.
Brown & Sharpe Mfg. Co., Providence, R. I.
Jones & Lamson Machine Co., Springfield, Vt.
National Acme Mfg. Co., Cleveland, O.
Niles-Bement-Pond Co., 136 Liberty St., New York.
Pratt & Whitney Co., Hartford, Conn.

Separators, Steam and Oil.

Allis-Chalmers Co., Chicago, Ill.
American Tool & Machine Co., Boston, Mass.
Austin Separator Co., Detroit, Mich.
John Davis Co., 51-79 Michigan St., Chicago, Ill.
Julian D'Este Company, 24 Canal St., Boston, Mass.
Direct Separator Co., Syracuse, N. Y.
Goubert Mfg. Co., 85 Liberty St., New York.
A. A. Griffing Iron Co., 66-68 Centre St., New York; Works, Jersey City.
Harrison Safety Boiler Works, 3138 N. 17th St., Philadelphia, Pa.
Hoppes Mfg. Co., Springfield, O.
Watson & McDaniel Co., Philadelphia, Pa.

Sewer Pipe Presses and Dies (Clay).

Turner, Vaughn & Taylor Co., Cuyahoga Falls, O.

Shafting—SEE PULLEYS.

Shapers.

Frank Machinery Co., Buffalo, N. Y.
Niles-Bement-Pond Co., 136 Liberty St., New York.
Potter & Johnson Machine Co., Pawtucket, R. I.
Pratt & Whitney Co., Hartford, Conn.
Wm. Sellers & Co., Inc., Philadelphia, Pa.
John Steptoe Shaper Co., Cincinnati, O.
Stockbridge Machine Co., Worcester, Mass.

Shears—SEE PUNCHING MACHINERY.

Sheet Metal Work.

Garry Iron & Steel Co., Cleveland, Ohio.
Globe Machine & Stamping Co., Cleveland, Ohio.
Lyon Metallic Mfg. Co., 18 S. Ann St., Chicago, Ill.

Shutters, Steel Rolling.

Kinnear Mfg. Co., Columbus, Ohio.

Skylights and Ventilators.

G. Drouvé & Co., Bridgeport, Conn.
Garry Iron & Steel Co., Cleveland, Ohio.

Special Machinery.

Globe Machine & Stamping Co., Cleveland, Ohio.

Speed Controllers.

Speed Control Co., The Bourse, Philadelphia, Pa.

Spike Machines.

National Machinery Co., Tiffin, Ohio.

Spiral Gears.

R. D. Nuttall Co., Pittsburg, Pa.

Stand Pipes.

Struthers-Wells Co., Warren, Pa.

Steam Engine Indicators.

Star Brass Mfg. Co., Boston, Mass.

Steam-Regulating Appliances.

American Steam Gauge & Valve Co., Boston, Mass.
Ashcroft Mfg. Co., 85-89 Liberty St., New York.
Crane Co., Chicago, Ill.
G. M. Davis Regulator Co., 144 Milwaukee Ave., Chicago, Ill.
Julian D'Este Co., 24 Canal St., Boston, Mass.
F. W. Foster Mfg. Co., Boston, Mass.
Harrison Safety Boiler Works, 3138 N. 17th St., Philadelphia, Pa.
Jenkins Brothers, 71 John St., New York.
Lunkenheimer Co., Cincinnati, Ohio.
Pittsburg Valve, Fdy. & Cons. Co., Pittsburg, Pa.
Power Specialty Co., 126 Liberty St., New York.
John Simmons Co., 110 Centre St., New York.
Tracy Engineering Co., San Francisco, Cal.
Walworth Manufacturing Co., Boston, Mass.
Watson & McDaniel Co., Philadelphia, Pa.
Williams Gauge Co., W. Pittsburg, Pa.

Steam Pile Hammers.

A. F. Bartlett & Co., Saginaw, Mich.

Steam Separators.

Austin Separator Co., Detroit, Mich.
Griffing Iron Co., Jersey City, N. J.
Harrison Safety Boiler Works, 3138 No. Seventeenth St., Philadelphia, Pa.

Steam Shovels.

Bucyrus Co., So. Milwaukee, Wis.
C. W. Hunt Co., West New Brighton, N. Y.
Marion Steam Shovel Co., Marion, Ohio.
Vulcan Iron Works Co., Toledo, Ohio.

Steam Specialties.

Ashcroft Mfg. Co., 85-89 Liberty St., New Y
Ashton Valve Co., Boston, Mass.
Austin Separator Co., Detroit, Mich.
Crane Co., Chicago, Ill.
Eagle Oil & Supply Co., 104 Broad St., Bo Mass.
G. M. Davis Regulator Co., 144 Milwaukee Chicago, Ill.
John Davis Co., 51-79 Michigan St., Chicago, Ill
Julian D'Este Company, 24 Canal St., Boston,
F. W. Foster Mfg. Co., Boston, Mass.
Foster Engineering Co., Newark, N. J.
Griffing Iron Co., Jersey City, N. J.
Harron, Rickard & McCone, 21 Fremont St., Francisco, Cal.
Lunkenheimer Co., Cincinnati, Ohio.
McNab & Harlin Mfg. Co., 56-60 John St., N.
Power Specialty Co., 126 Liberty St., New Yor
John Simmons Co., 110 Centre St., New York
Richard Thompson & Co., 126 Liberty St., New
Tracy Engineering Co., San Francisco, Cal.
Walworth Mfg. Co., Boston, Mass.
Watson & McDaniel Co., Philadelphia, Pa.
Wright Mfg. Co., Detroit, Mich.

Steam Superheaters.

Power Specialty Co., 126 Liberty St., New Yor

Steam Traps.

American Blower Co., Detroit, Mich.
G. M. Davis Regulator Co., 144 Milwaukee Chicago, Ill.
Julian D'Este Company, 24 Canal St., Boston,
A. A. Griffing Iron Co., 66-68 Centre St., York; Works, Jersey City, N. J.
John Simmons Co., 110 Centre St., New York
B. F. Sturtevant Co., Jamaica Plain Station, ton, Mass.
Walworth Manufacturing Co., Boston, Mass.
Watson & McDaniel Co., Philadelphia, Pa.
Wright Mfg. Co., Detroit, Mich.

Steel.

Wm. Jessop & Sons, Ltd., 91 John St., New
Kloman Co., Pittsburg, Pa.
Latrobe Steel Co., Philadelphia, Pa.
Maryland Steel Co., Sparrows Point, Md
Pennsylvania Steel Co., Steelton, Pa.
E. M. Shaw, Providence, R. I.
Taylor Iron and Steel Co., High Bridge, N. J.
Walworth Manufacturing Co., Boston, Mass.
Willamette Iron & Steel Wks., Portland, Ore.

Steel Balls.

Federal Mfg. Co., Cleveland, O.

Steel Pipe Flanges.

Latrobe Steel Co., 1200 Girard Bldg., Phila., P

Steel Rings.

Latrobe Steel Co., 1200 Girard Bldg., Phila., P

Steel Shells.

Latrobe Steel Co., 1200 Girard Bldg., Phila., P

Steel Tanks.

L. O. Koven & Bro., 50 Cliff St., New York Cit
Lyon Metallic Mfg. Co., 18 S. Ann St., Chicago,

Steel Tote Boxes.

Lyon Metallic Mfg. Co., 18 S. Ann St., Chicago,

Stokers—Mechanical.

Babcock & Wilcox Co., 85 Liberty St., New Y
Ross & Co., 95 Liberty St., New York.
Wm. Sellers & Co., Inc., Philadelphia, Pa.
Westinghouse Machine Co., Pittsburg, Pa.
Westinghouse, Church, Kerr & Co., 26 Cortl St., New York.

Storage Batteries.

Electric Storage Battery Co., Philadelphia, Pa.

Structural Iron Work.

Chester B. Albree, Allegheny, Pa.
American Bridge Co., 100 Broadway, N. Y.
Berlin Construction Co., Berlin, Conn.
Browning Engineering Co., Cleveland, Ohio.
Garry Iron and Steel Co., Cleveland, O.
Riter-Conley Mfg. Co., Pittsburg, Pa.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

Sugar-House Machinery.

American Tool & Machine Co., Boston, Mass.
Jeffrey Manufacturing Co., Columbus, Ohio.
Link-Belt Eng'g Co., Nicetown, Philadelphia,
Robins Conveying Belt Co., 14-22 Park Row,
R. D. Wood & Co., Philadelphia, Pa.

Tanks, Iron.
Allis-Chalmers Co., Chicago, Ill.
Atlantic Works, East Boston, Mass.
Aultman Company, Canton, Ohio.
Flint & Walling Mfg. Co., Kendallville, Md.
L. O. Koven & Brother, 50 Cliff St., New York.
Riter-Conley Mfg. Co., Pittsburg, Pa.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.
S. Morgan Smith Co., York, Pa.
Struthers-Wells Co., Warren, Pa.
Robt. Wetherill & Co., Chester, Pa.
U. S. Wind Engine & Pump Co., Batavia, Ill.

Tanks.
W. E. Caldwell Co., Louisville, Ky.
Flint & Walling Mfg. Co., Kendallville, Md.
Lacy Mfg. Co., 334 N. Main St., Los Angeles, Cal.
U. S. Wind Engine & Pump Co., Batavia, Ill.

Taps and Dies.
Crane Co., Chicago.
Morse Twist Drill & Mch. Co., New Bedford, Mass.
Standard Tool Co., Cleveland, Ohio.

Tapping and Reaming Machines.
Philadelphia Pneumatic Tool Co., Philadelphia, Pa.
Pratt & Whitney Co., Hartford, Conn.
Stow Flexible Shaft Co., Philadelphia, Pa.

Telephones.
Ericsson Telephone Co., 296 Broadway, New York

Tenoning Machines.
J. A. Fay & Egan Co., 212-232 West Front St., Cincinnati, Ohio.

Thermometers.
Bristol Co., Waterbury, Conn.
Hohmann & Maurer Mfg. Co., Rochester, N. Y.

Time Recorders.
Am. Watchman's Time Detector Co., Cleveland, O.

Tin Plate Mills.
Diamond Drill & Machine Co., Birdsboro, Pa.
E. H. Stroud & Co., Chicago, Ill.

Tire Plates.
Atlas Railway Supply Co., Chicago, Ill.

Tires—Steel.
Latrobe Steel Co., Philadelphia, Pa.

Transmitting Machinery.
Minneapolis Steel & Machinery Co., Minneapolis, Minn.

Traveling Cranes.
Case Mfg. Co., Columbus, Ohio.
Hayden & Derby Mfg. Co., New York.
Hayward Co., 97 Cedar St., New York.
Niles-Bement-Pond Co., 136 Liberty St., New York.
Shaw Electric Crane Co., Muskegon, Mich.

Trucks.
City Forge & Iron Works, Dayton, O.

Tumbling Barrels.
Globe Machine & Stamping Co., Cleveland, Ohio.

Tumbling Mills.
S. Obermayer Co., Cincinnati, Ohio.

Turnbuckles.
John Simmons Co., 110 Centre St., New York.

Turn Tables.
Arthur Koppel, 68 Broad St., New York.
Wm. Sellers & Co., Philadelphia, Pa.

Turret Lathes.
American Tool & Machine Co., Boston, Mass.
Bullard Machine Tool Co., Bridgeport, Conn.
Jones & Lamson Machine Co., Springfield, Vermont, U. S. A.
Niles-Bement-Pond Co., 136 Liberty St., New York.
Pratt & Whitney Co., Hartford, Conn.

Twist Drills.
Standard Tool Co., Cleveland, Ohio.

Vacuum and Draft Gauges.
Bristol Co., Waterbury, Conn.
Hohmann & Maurer Mfg. Co., Rochester, N. Y.

Vacuum Pumps.
Alberger Condenser Co., 95 Liberty St., New York.
A. S. Cameron Steam Pump Wks., E. 23d St., N. Y.
Clayton Air-Compress. Wks., 114 Liberty St., N. Y.
Deane Steam Pump Co. of Holyoke, 116 Liberty St., New York.
Guild & Garrison, Brooklyn, N. Y.
John H. McGowan Co., Cleveland, Ohio.

Valves—Gas, Steam, and Water.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Ashton Valve Co., Boston, Mass.
Boston Belting Co., Boston, Mass.
Consolidated Safety Valve Co., 85-89 Liberty St., New York.
Crane Co., Chicago, Ill.
Crosby Steam Gage & Valve Co., Boston, Mass.
G. M. Davis Regulator Co., 144 Milwaukee Ave., Chicago, Ill.
Detroit Leather Specialty Co., Detroit, Mich.
John Davis Co., 51-79 Michigan St., Chicago, Ill.
Julian D'Este Company, 24 Canal St., Boston, Mass.
F. W. Foster Mfg. Co., Boston, Mass.
Jenkins Bros., 71 John St., New York.
Kelly & Jones Co., Greensburg, Pa.
Kennedy Valve Mfg. Co., 70 Beekman St., N. Y.
Lunkenheimer Co., Cincinnati, Ohio.
John H. McGowan Co., Cincinnati, Ohio.
Pittsburg Valve, Fdy. & Cons. Co., Pittsburg, Pa.
Ross Valve Co., Troy, N. Y.
John Simmons Co., 110 Centre St., New York.
Star Brass Mfg. Co., Boston, Mass.
Walworth Mfg. Co., Boston, Mass.
Watson & McDaniel Co., Philadelphia, Pa.

Ventilating Appliances—SEE HEATING AND VENTILATING.

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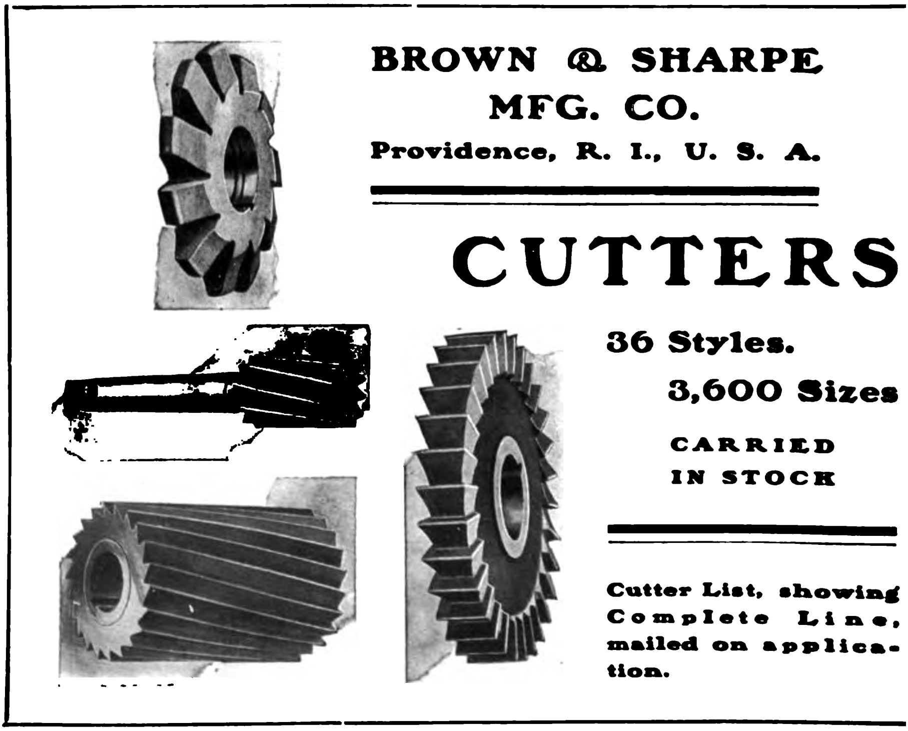

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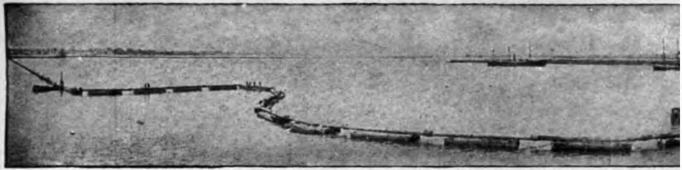

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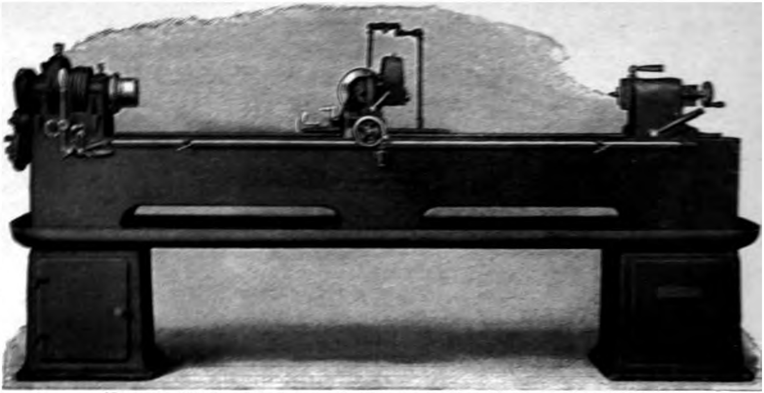

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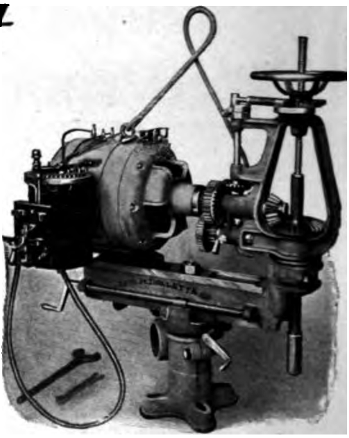

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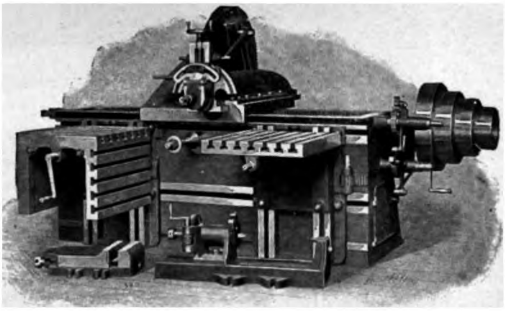

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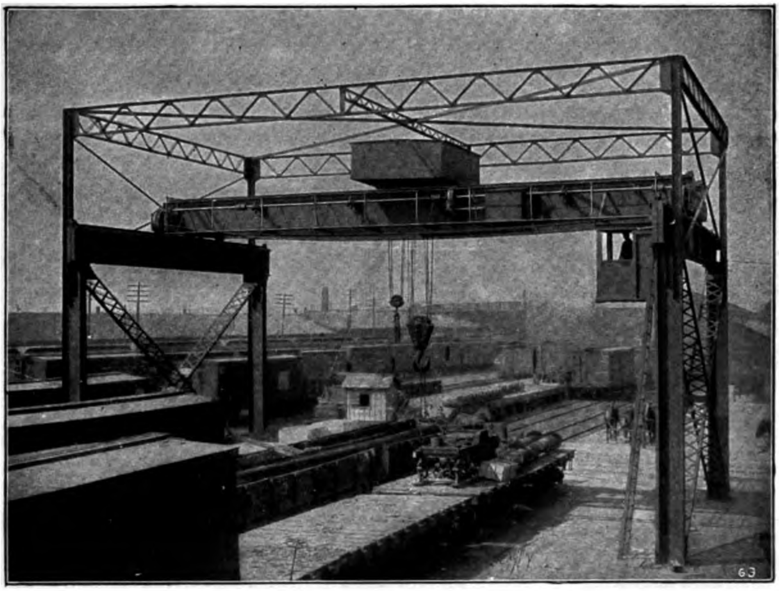

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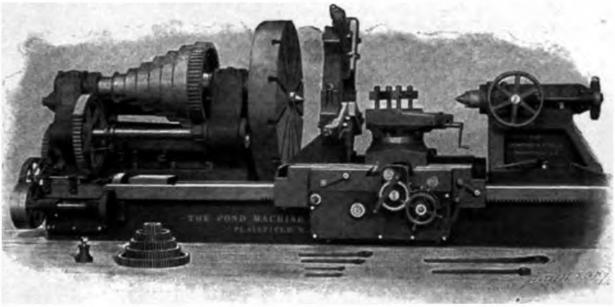

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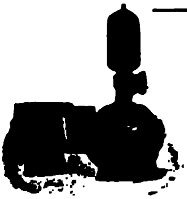

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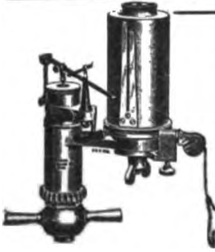

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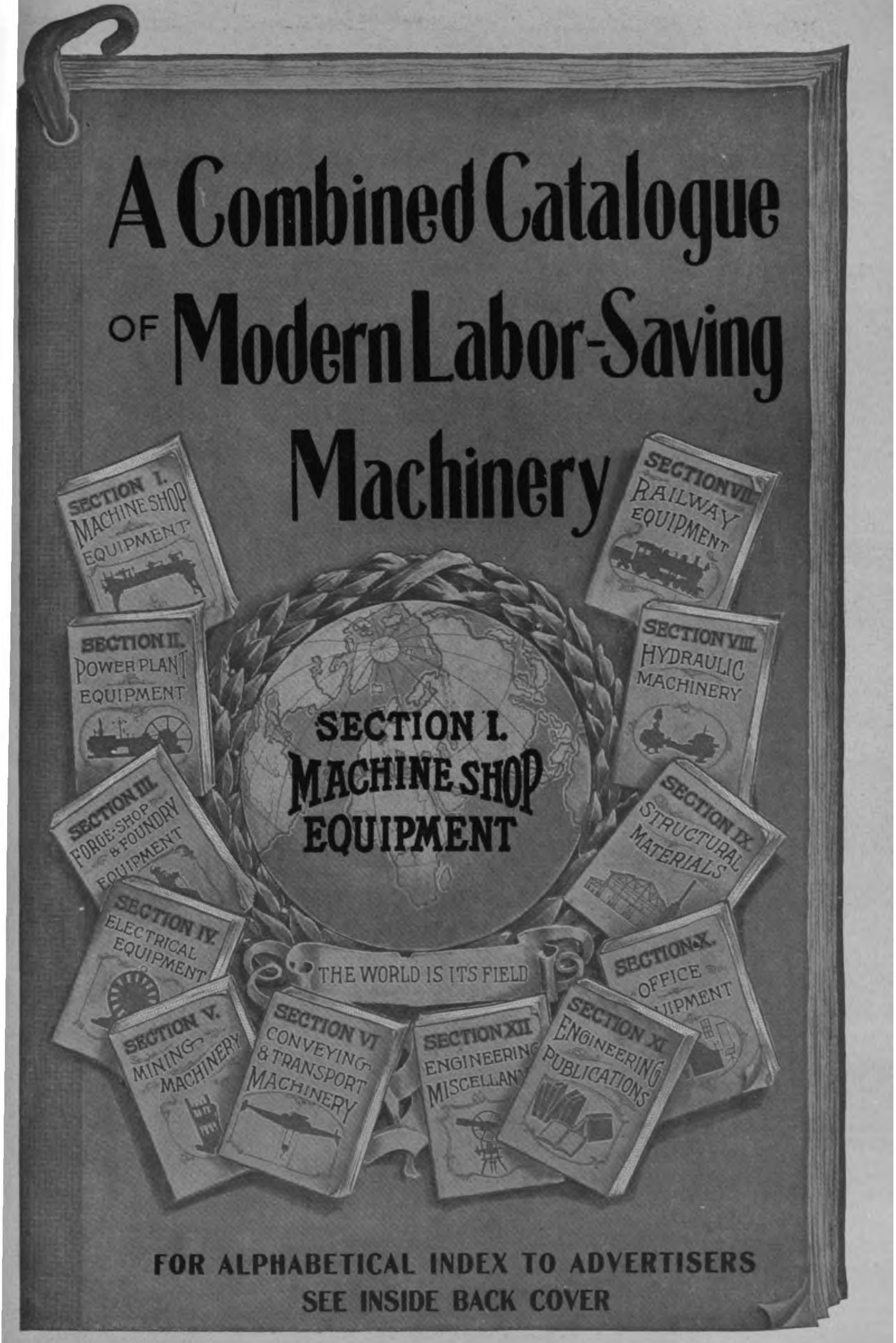
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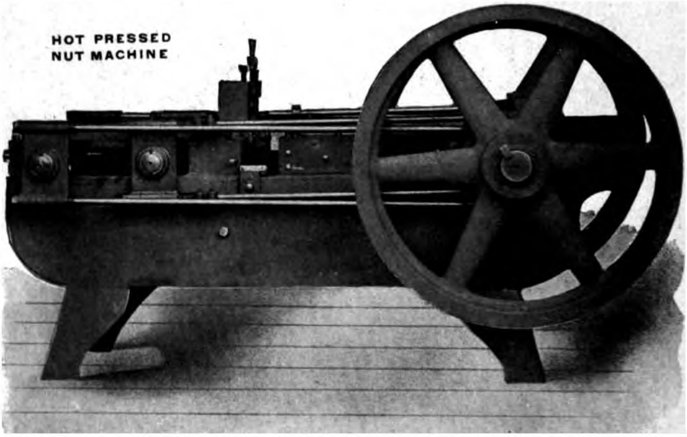
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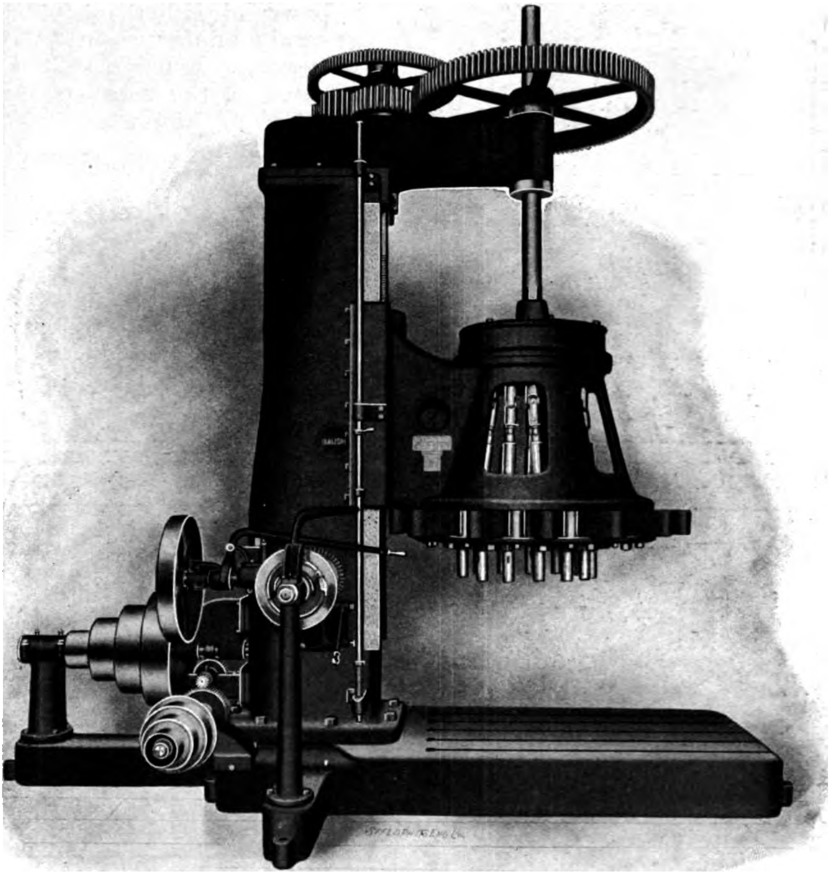

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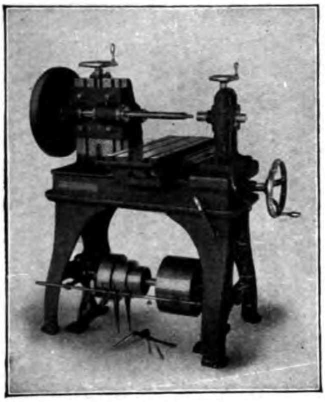

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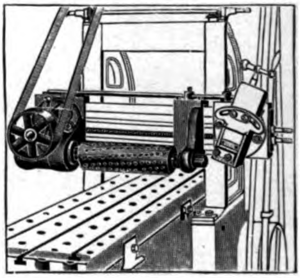

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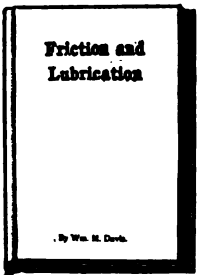

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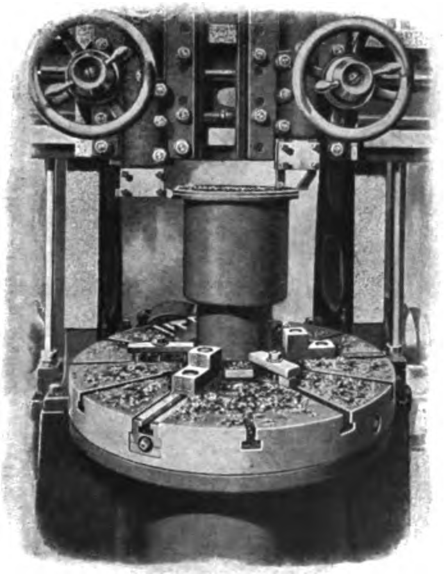

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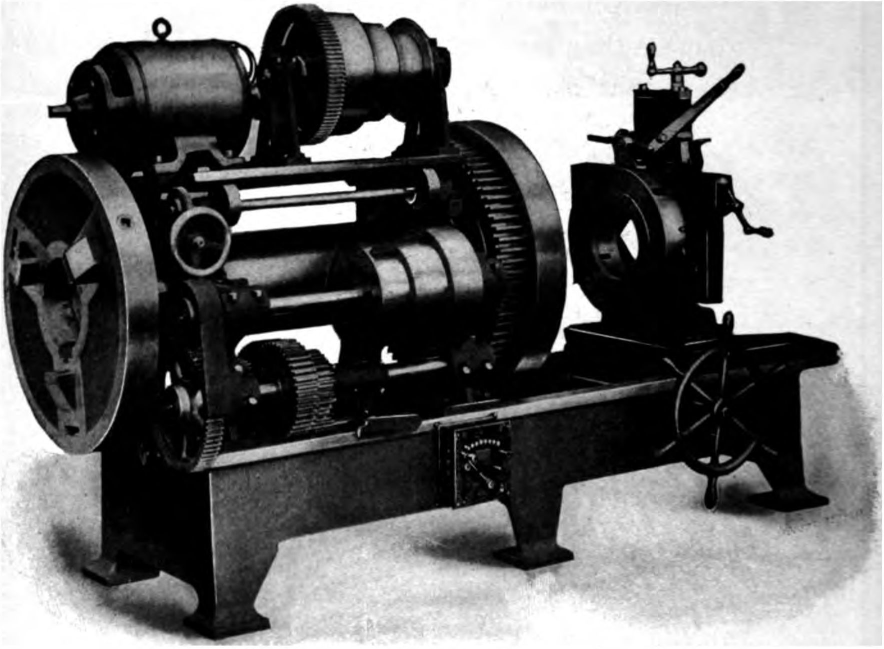

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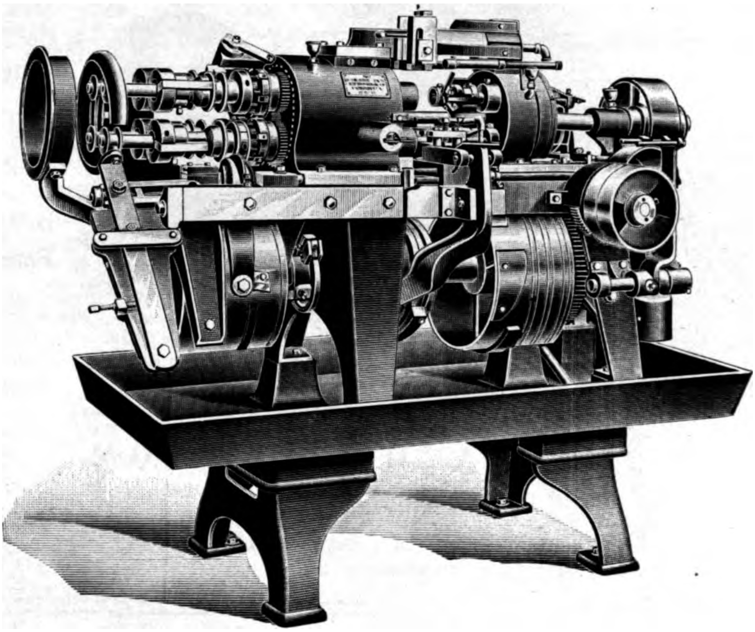

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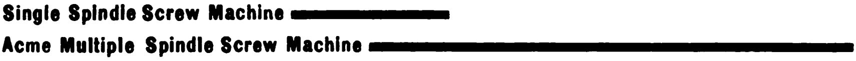

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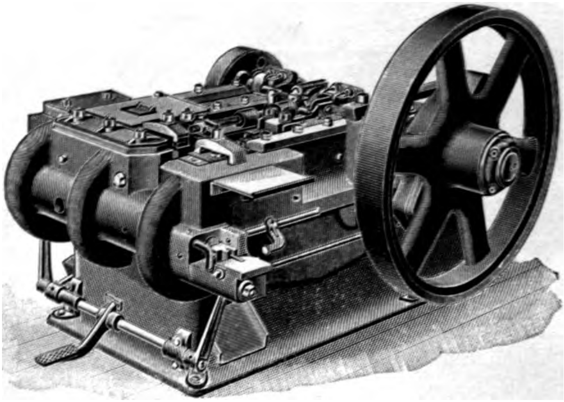

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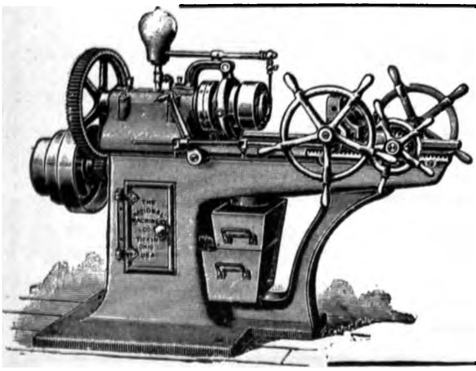

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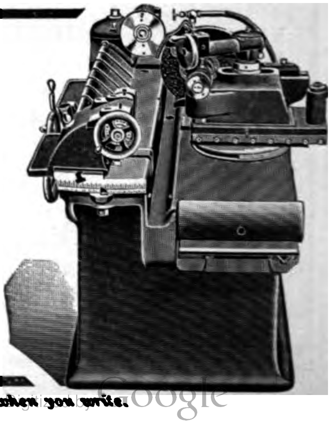

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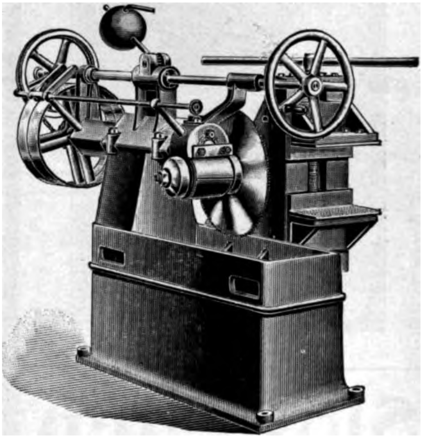

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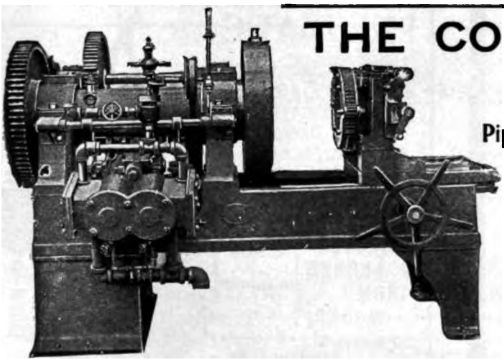

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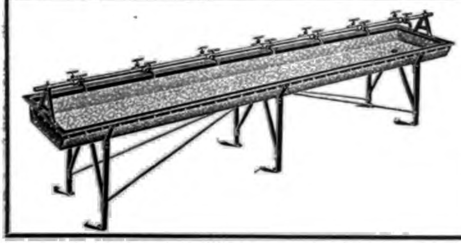

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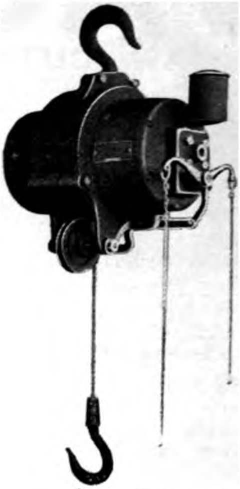

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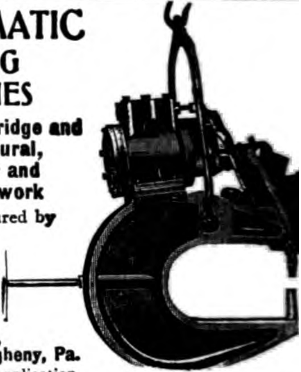

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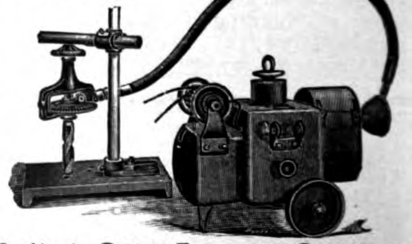

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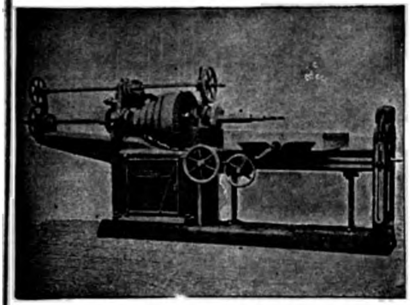

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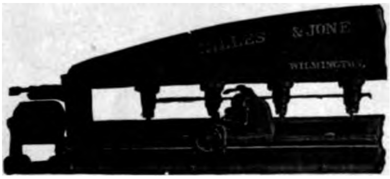

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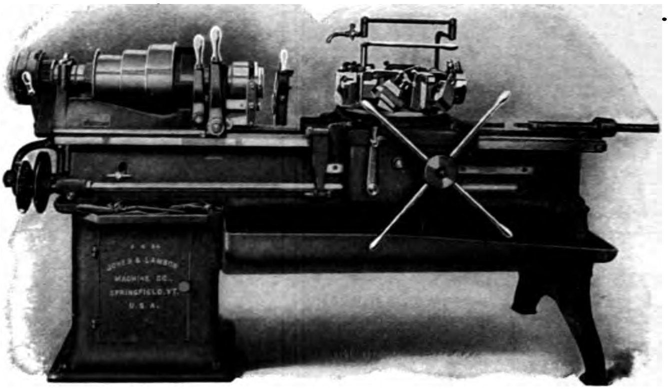

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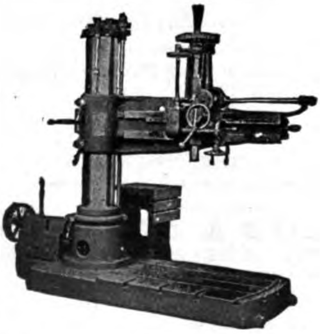

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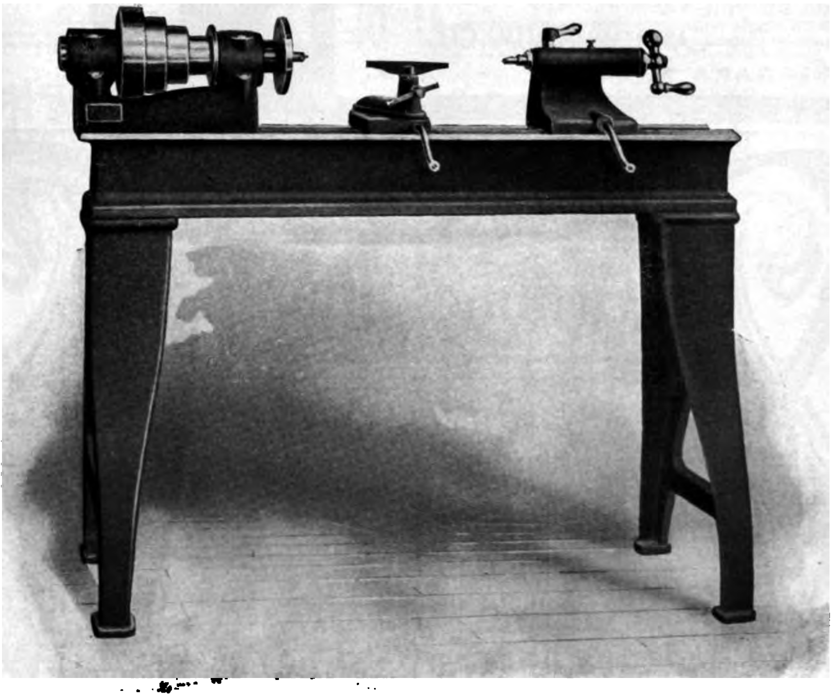

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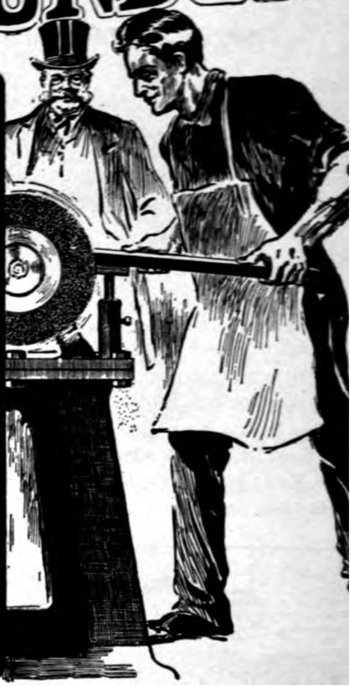

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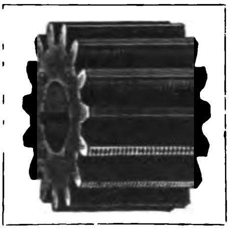

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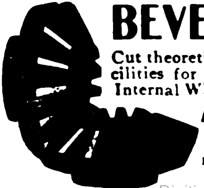

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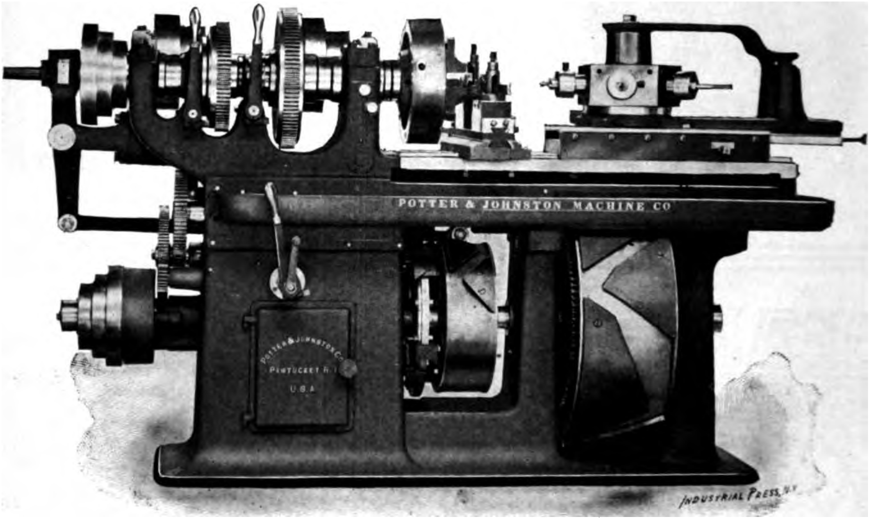

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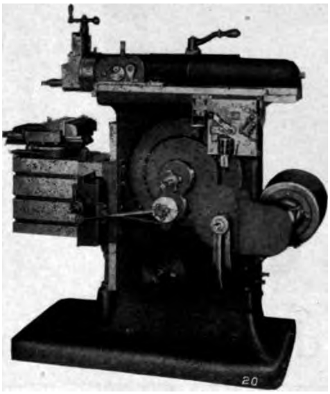

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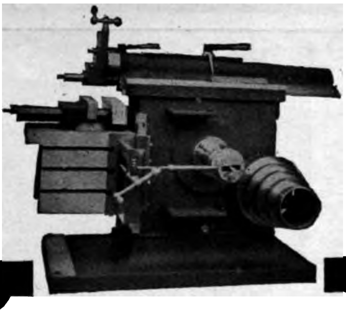

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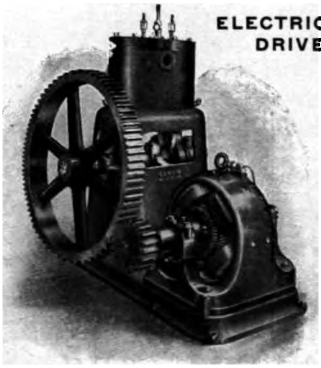

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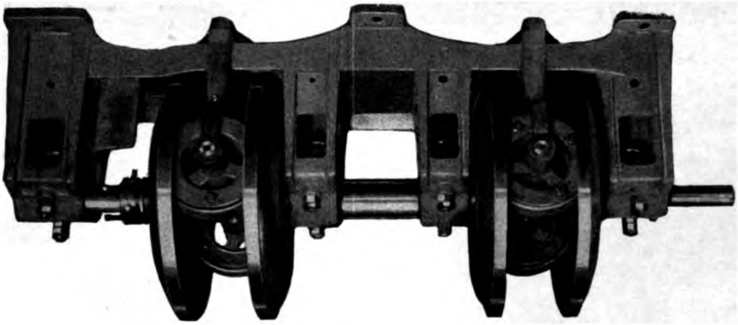

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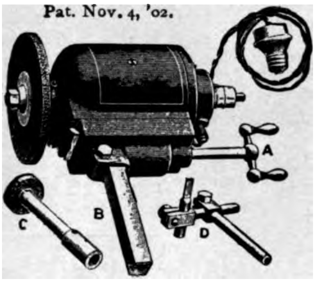

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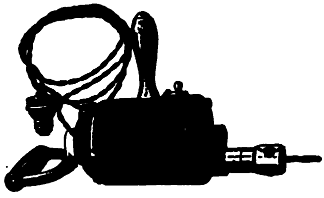

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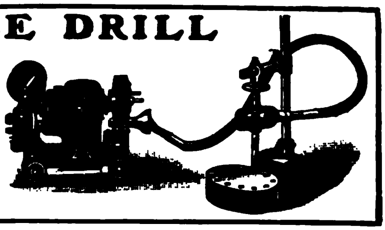

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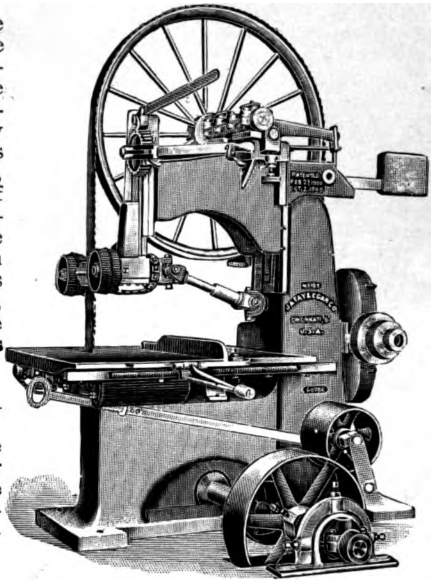

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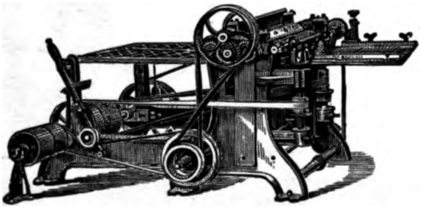

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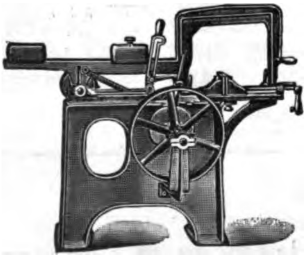

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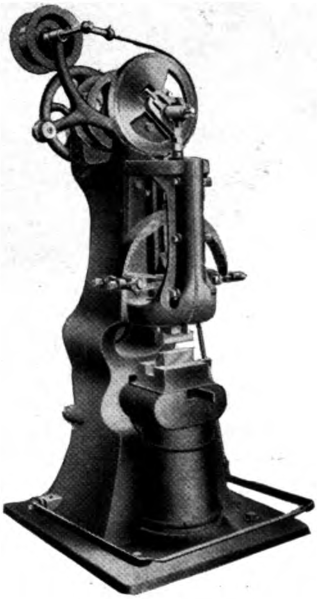

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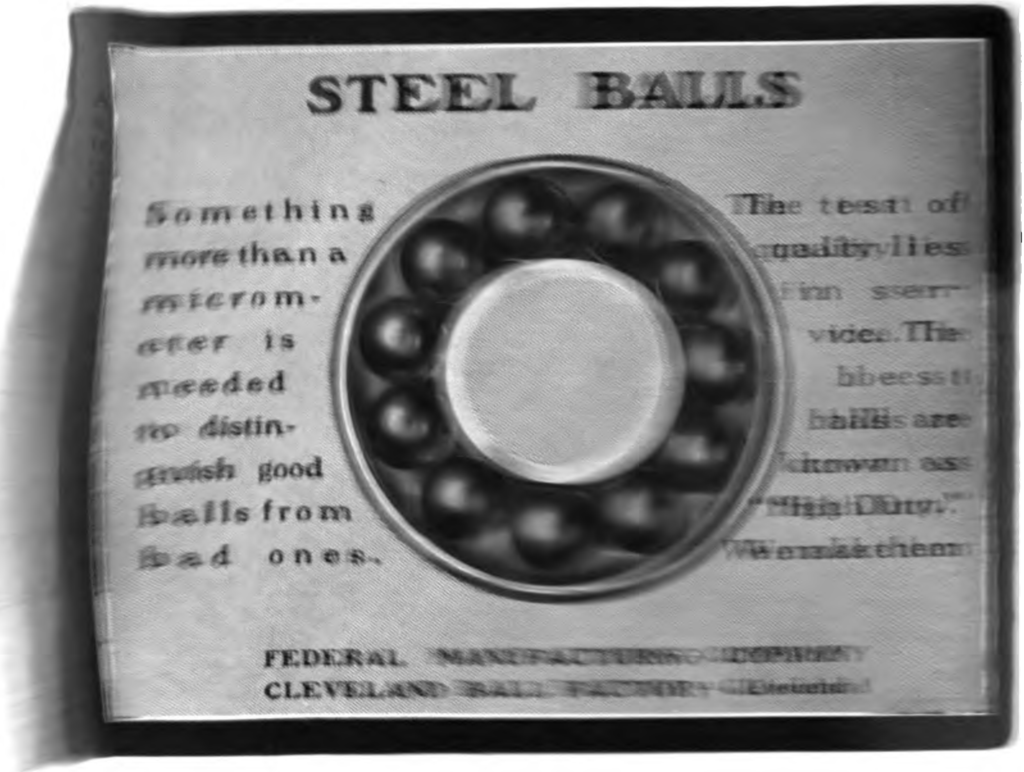

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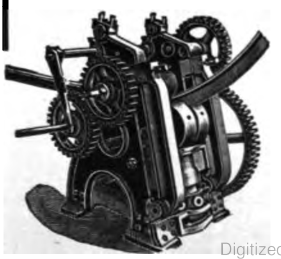

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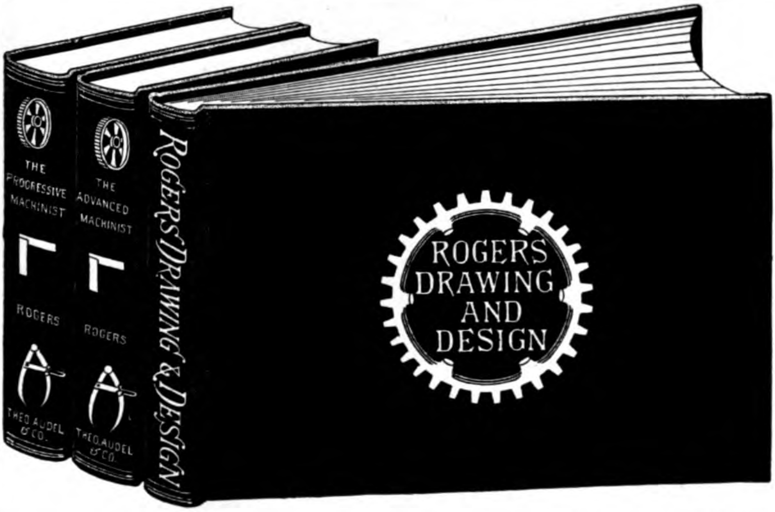

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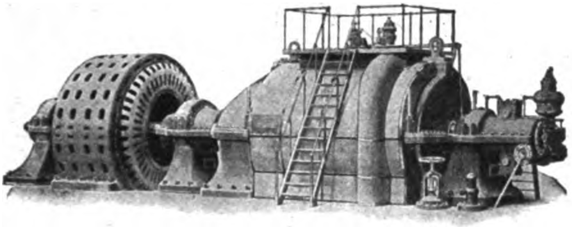

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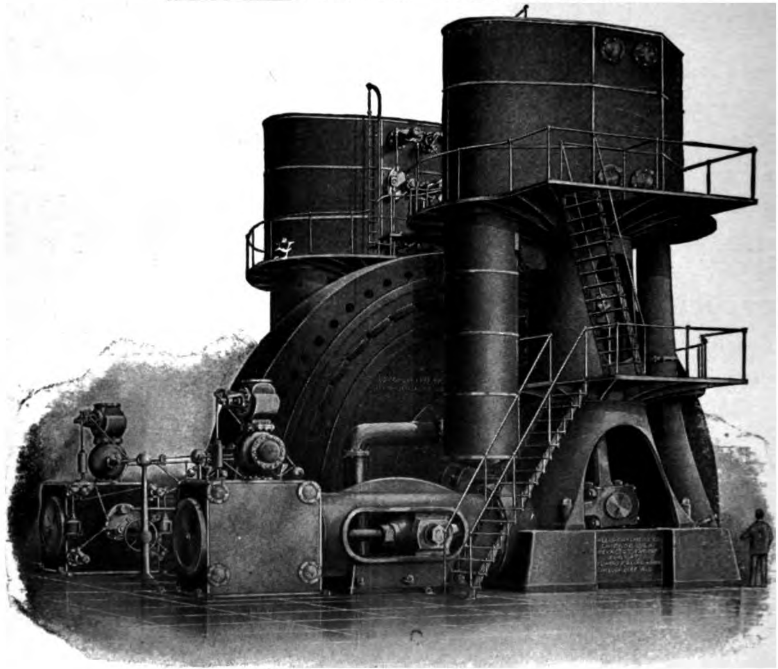

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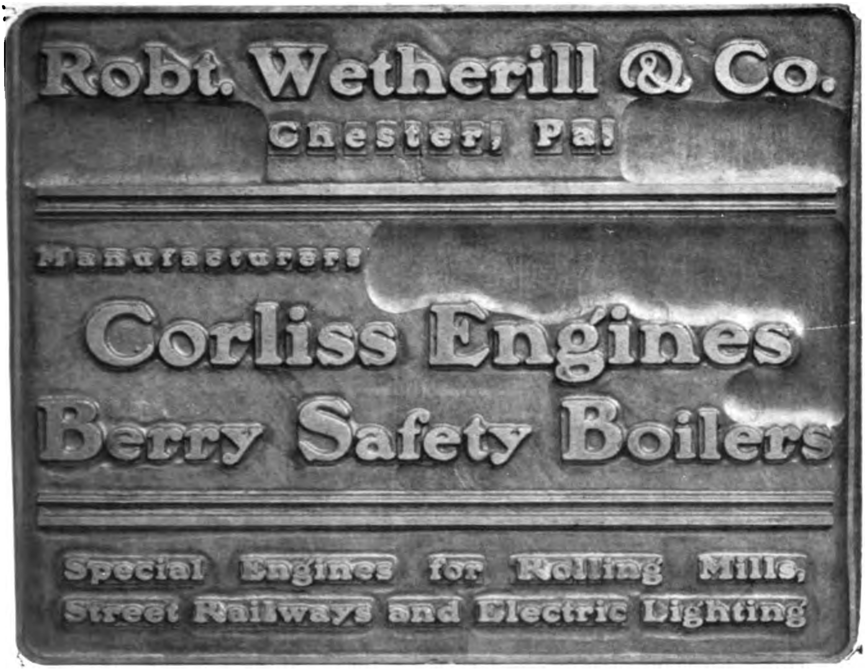

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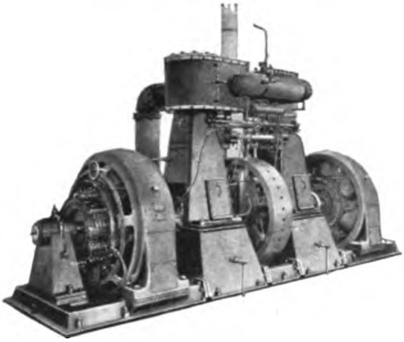

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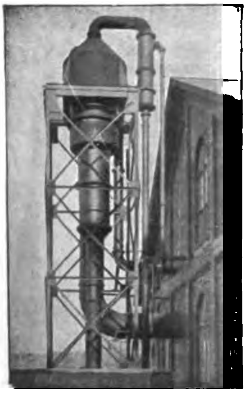

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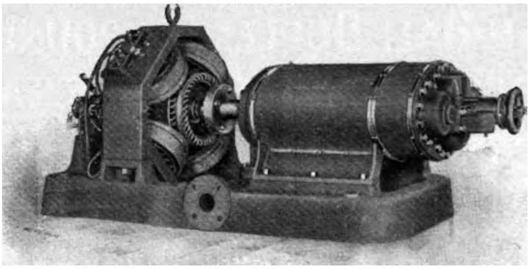

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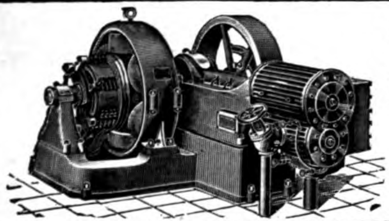

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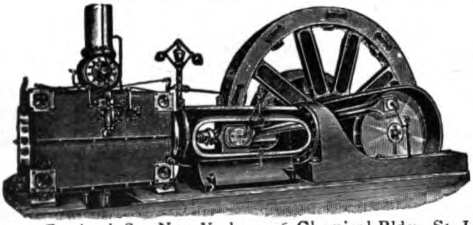

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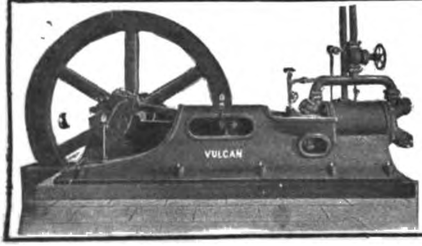

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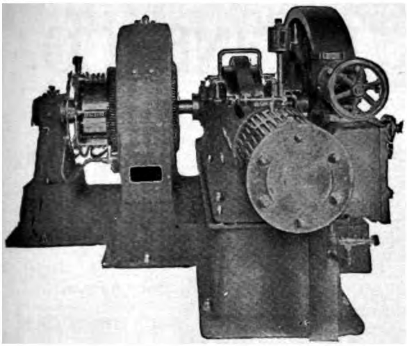

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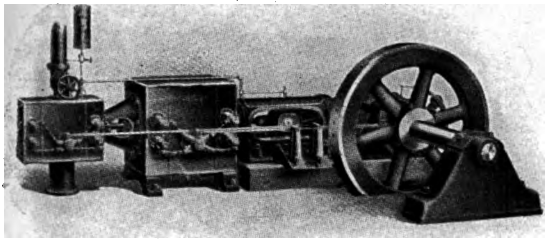

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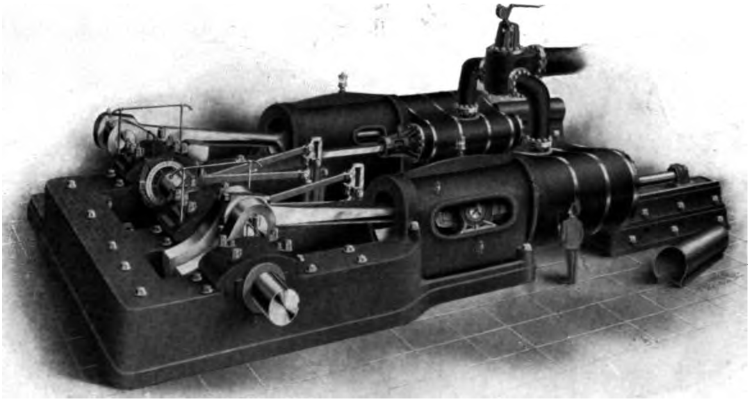

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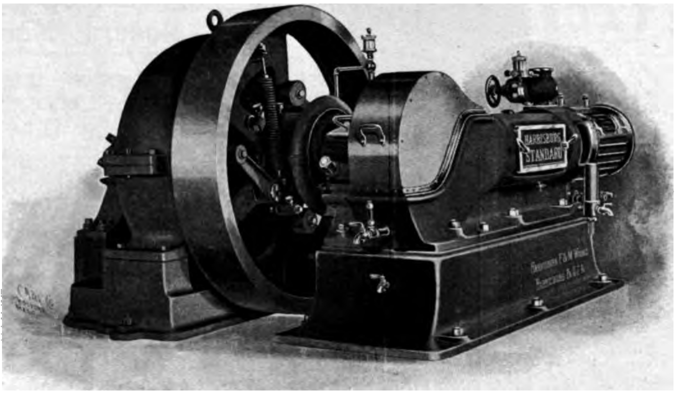

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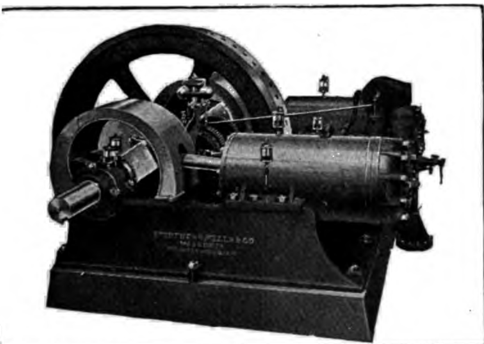

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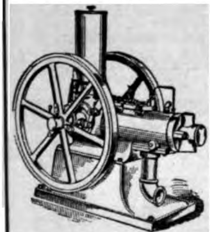

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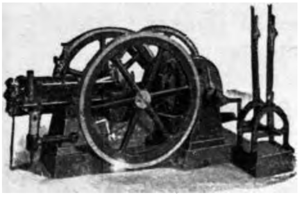

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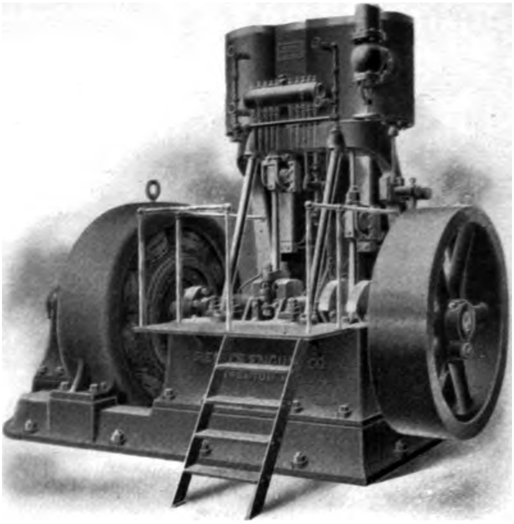

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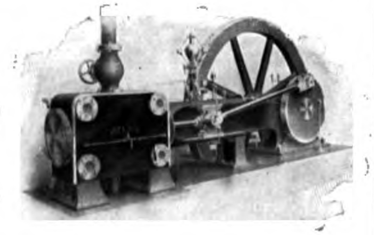

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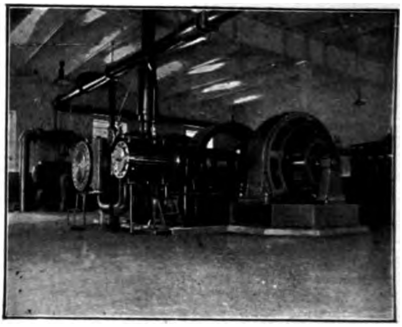

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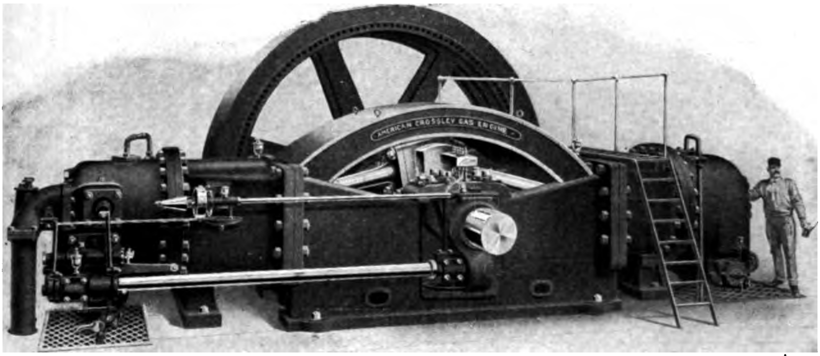

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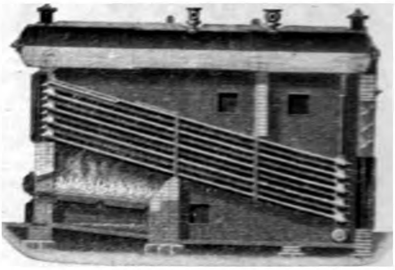

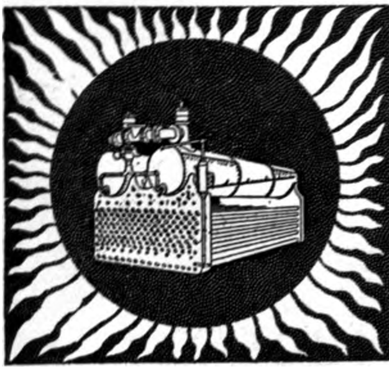

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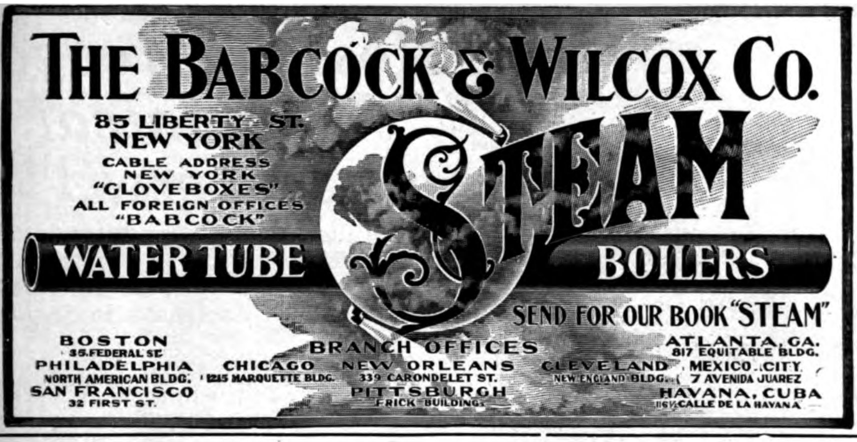

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will clean your
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and keep it in good condition always. Ask us about it.

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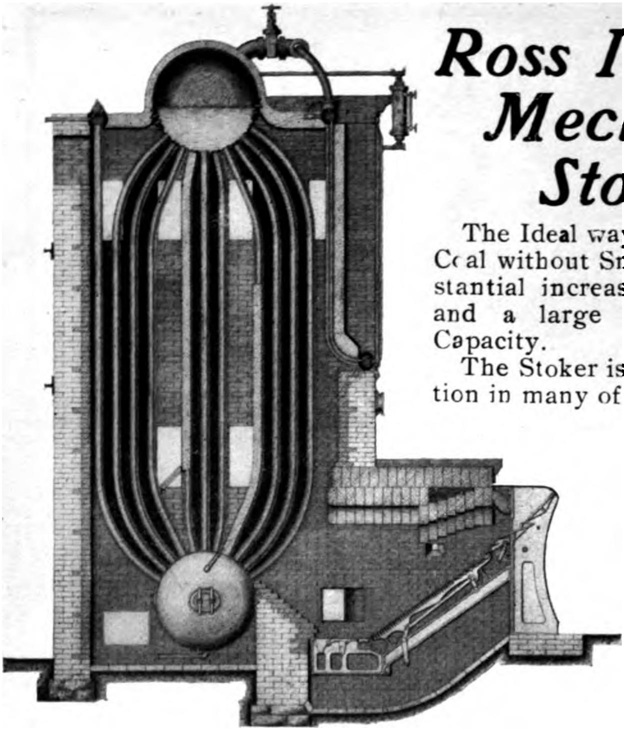

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The Ideal way to burn Bituminous Coal without Smoke, to secure substantial increase in fuel economy, and a large increase in Boiler Capacity.

The Stoker is in successful operation in many of the largest Electric Light, Railway, and Industrial Plants in the United States.

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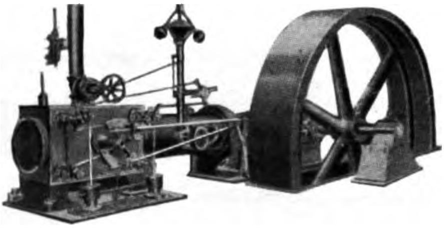

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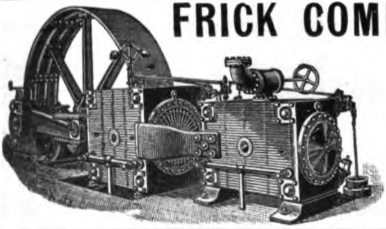

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It's valuable because it tells how to save hundreds of dollars every year in addition to describing the Dean Boiler Tube Cleaner.

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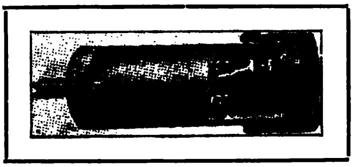

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Boiler scale eats up hundreds of dollars in fuel every year and it can only be removed by means of the

Dean Cleaner

To prove this we'll loan you a cleaner (free of all cost and without placing you under any obligations to buy) for a thorough trial in your own boiler.

We guarantee this cleaner to at least pay for itself in 6 months' use.

Over 5,000 in successful use now. Don't delay but write to-day.

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The Parson System

THE building of boiler furnaces is our specialty. We have been at it thirty years.

We have enabled very many of our customers to save **$1.00 a ton** on their coal.

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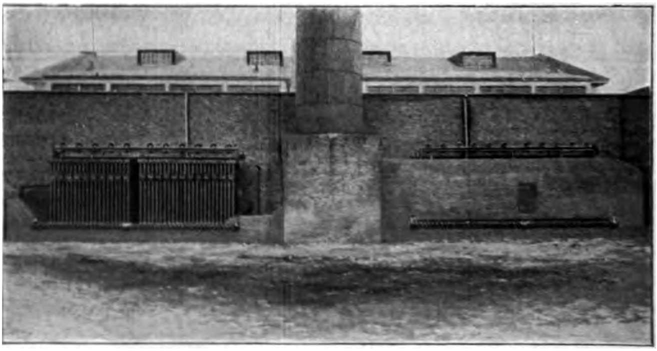

Should be, from the view-point of economy, one of the first considerations, when **designing** new steam plants or re-modeling the old. Saves from 10 to 20% on fuel **supply—heats** entire plant without additional cost. Cut shows Economizer in course of erection.

BOOKLET FREE

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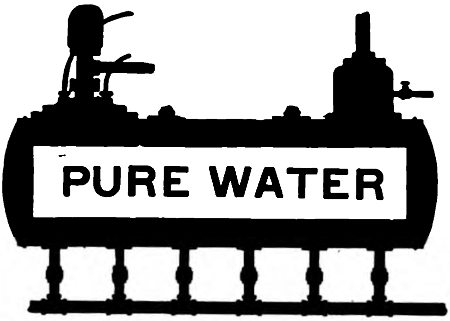

The Clark Electric Water Purifier

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IS the most perfect device in the world for purifying water for drinking and manufacturing purposes.

It removes all impurities from water.

Fit a Clark Electric Water Purifier with copper tubes and you have a feed-water heater which can purify sea water for use in boilers on ocean and river steamers.

By this method ice can be made much cheaper, because the same results can be obtained WITHOUT evaporation.

No scaling of boilers by its use, thereby saving considerable expense for fuel and prolonging the life of boilers.

We guarantee our system to be as represented or money refunded.

Plants installed on short notice.

Full description sent on request.

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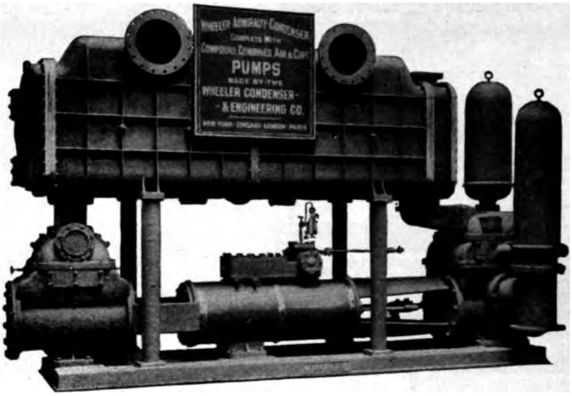

Wheeler Condenser complete with Compound Combined Air and Circulating Pumps.

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STANDARD STEAM ECONOMIZERS

Installed in Some of the Largest Plants in this Country and Abroad.

We are prepared to build Condensers of capacities ranging from 25 H. P. to 10,000 H. P. to suit all conditions and specifications.

We also manufacture Feed Water Heaters, Evaporators, Centrifugal Pumps, Cooling Towers, etc.

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WATER SOFTENING AND PURIFYING SYSTEMS

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Makes a true record night and day in ink of pressure carried. Now in general use in almost every kind of power plant, are money savers, as well as assuring safety. They record the exact pressure carried in boiler, generator, pipes, pumps, etc. Also Engine and Boiler appliances in general. Send for Catalogue X.

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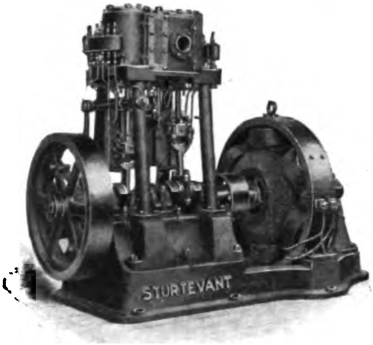

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in all types and sizes. Engines from 2 to 400 H. P. Direct current motors of any required power. Generating sets from 1½ to 250 K. W.

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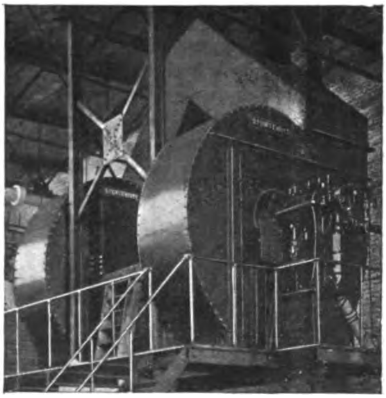
System of Mechanical Draft



No chimney required, but may be applied to old plants in connection with a chimney.

Will increase the boiler capacity and reduce the coal bill by burning cheap fuel.

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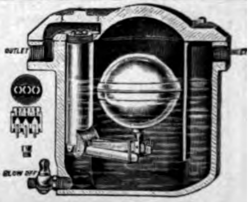

3

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There are three outlet valves in the

WRIGHT "EMERGENCY" HIGH-PRESSURE STEAM TRAP

One valve for ordinary amounts of condensation. Two more valves in reserve for emergencies. All three help to make a wasteless trap of wonderful capacity. Ask for catalog.

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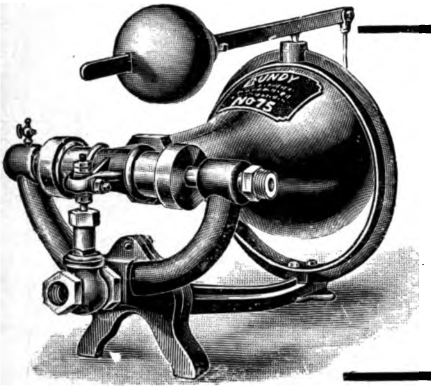

THE SALE OF BUNDY STEAM TRAPS IS UNPRECEDENTED. EVERYBODY SEEMS TO BE ORDERING THEM

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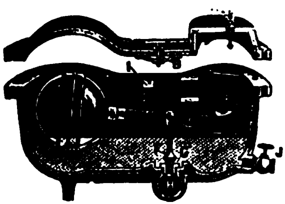

The McDaniel Steam Trap . . .

DISCHARGES CONTINUOUSLY AND NEVER BLOWS STEA
MADE EXTRA HEAVY FOR HIGH PRESSURE.
We also manufacture Reducing Valves, Exhaust Pipe Head
Separators for Live and Exhaust Steam, Blow Off Valve
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JULIAN D'ESTE COMPANY
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Return Steam Trap

will automatically return condensed water (at any temperature) to the boiler without loss of heat.

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MINING PUMPING
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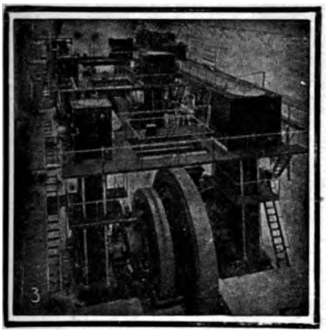

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Pressure Reducing Valves
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All Jobbers sell them— Catalog on application

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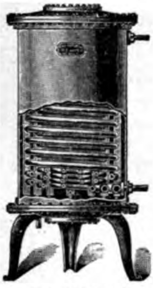
NEW YORK OFFICE, 123 LIBERTY ST.



THE NATIONAL

The National Feed-Water Heater

Simple, Cheap, Reliable

Full amount of heating surface in every heater.
Supplies Water to the Boiler at 212° Fahr.

Makers of the Original Coil Feed-Water Heater.
All kinds of Coils in Iron and Copper Pipe.

THE NATIONAL PIPE BENDING CO.

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Catalog and Estimates
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1,500,000
Horse Power
in Daily Use

You Have Seen Austin Separators Advertised for Years--

STILL, THERE ARE NEW AUSTIN SEPARATORS.

NEW patterns designed to meet new conditions — Separators that are products of the times —the kind your plant requires.

☞ The work that Austin Separators are built to do, is this—

To Eliminate Moisture from Live Steam; and

To Extract Oil and Other Impurities from Exhaust.

To do this work, we provide many different types of separators to suit varied conditions.

A few remedies, no matter how good, will not cure every ailment.

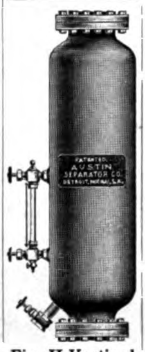

Fig. H, Vertical

And likewise, in these progressive days, two patterns of separators will not cover all the various requirements met with in different plants.

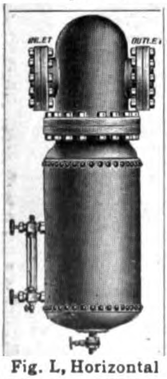

Fig. L, Horizontal

Right here is the advantage of buying an Austin Separator—from our complete line you can get a separator that will meet your particular requirements in every detail. The separator that will save you the most money in operation.

Mail us your requirements and conditions, and we will quote you. Send for catalogue.

AUSTIN SEPARATOR CO.

26 Woodbridge St., Detroit, Mich., U. S. A.

New York 149 Centre St.
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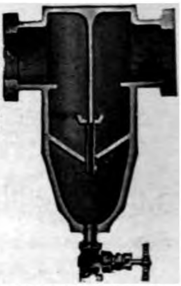
The Eclipse Separator

is so built that the condensation or oil after being separated from the steam does not come in contact with the separated steam. See sectional view. The condensation after separation passes through the pipe into lower chamber and dry steam passes around and out.



Tests made by one of the largest colleges show less than 1 per cent. of moisture in steam after passing through the separator.

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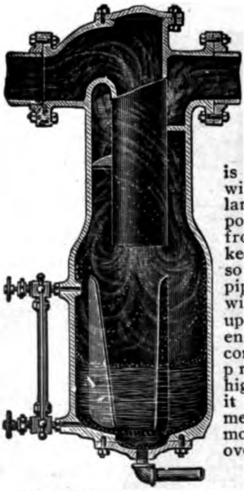
The Only One



All Separators have their merits. But the

Stratton Separator

is *the only one* that will take care of a large influx of water, positively separate it from the steam, and keep it separated, and so long as the drain pipe is open no water will be again picked up and carried to the engine. That involves considerably larger proportions and higher first cost. But it is a wise investment — you get your money back over and over again.

* * *

"Dry Steam" is the title of our new pamphlet—written by a distinguished engineer—worth money to every intelligent reader. Free to all parts of the world on request.

GOUBERT MFG. COMPANY,

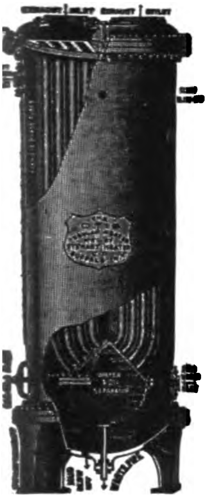
85 Liberty Street, New York, U. S. A.

REDUCE YOUR COAL BILLS!

By Putting your water in the Boiler at Boiling Point.

...THE OTIS...

Tubular Feed Water Heater and Purifier,



With Seamless Brass Tubes.

Guaranteed to heat the feed water to the **Boiling Point** (210° or 212°) with the exhaust steam without causing any back pressure. Also to **Extract the Oil** from the exhaust so that the exhaust steam, after being passed through the heater, can be used for heating purposes and the water of condensation from the heating system be returned to the boilers without the extra expense of an additional oil separator or eliminator.

WE GUARANTEE THIS HEATER WILL NOT GET FOUL WITH SEDIMENT.

A LIBERAL OFFER. Try us! If this heater fails to give satisfaction in every respect we will pay freight, cartage and all expenses.

Patented and Manufactured by the

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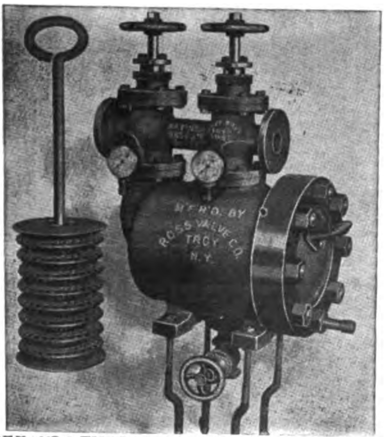

DEMANDS THAT YOU KEEP OIL OUT OF IT

WITH THE

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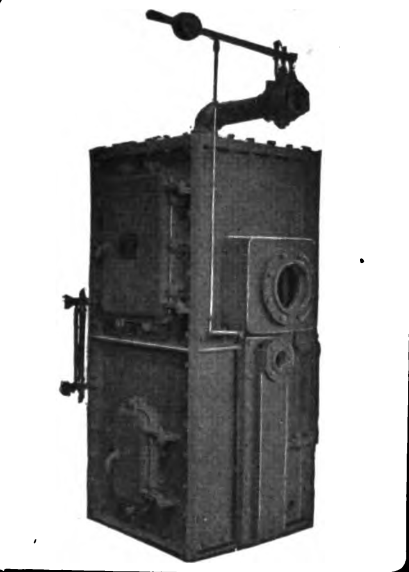
FOR MARINE OR LAND SERVICE.

Ask for full descriptive circular, giving a list of important vessels using this filter.

THE ROSS VALVE CO., Troy, N. Y.



A Short Story

"Thoroughfare" heater. Engineer forgot to open escape-valve. By-pass was closed. Engineer opened inlet valve. Bang! Heater blew up.

WEBSTER FEED-WATER HEATERS AND PURIFIERS,

not being "thoroughfare" heaters, are safe from such accidents. Then, as they use only just enough steam to heat the feed-water to the boiling point, they are unequalled for economy. Write for booklet.

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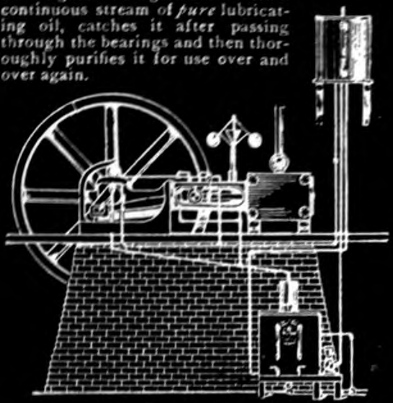
CONTINUOUS OILING SYSTEM

Mechanically handles the oil, keeps the engine bearings flooded with a continuous stream of *pure* lubricating oil, catches it after passing through the bearings and then thoroughly purifies it for use over and over again.



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Continuous Oiling Systems
Employing the duplex and Multiplex types White Star Oil Filters to meet the requirements and varying conditions of any size power station.
Send for Booklet "B" and list of installations.

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That Virtually No Exhaust Steam

THE WRIGHT CYCLONE EXHAUST HEAD WRIGHT MFG. CO. DETROIT, MICH. U.S.A.
WASTE

comes out of a **WRIGHT CYCLONE EXHAUST HEAD** is the best proof of its money-saving value. Roofs and walls are not showered with wet, oily spray, but instead, the latter is carried down the waste pipe. This Exhaust Head is scientific in principle, noiseless in operation, and very strongly built. Catalog will interest you.

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Dart Patent Unions and Flanges
Unsurpassed! Unapproachable! Tight Joints Assured.
Made by E. M. DART MFG. CO., :: :: PROVIDENCE, R. I.

HIGH GRADE
Steam Specialties
WRITE FOR TRIAL OFFER
The Tracy Engineering Co.
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FEED-WATER HEATERS,
STEAM SEPARATORS.
Live Steam
Feed-Water **Purifiers**
Guaranteed to keep boilers clean and free from scale.
Catalogue free
The Hoppes Mfg. Co.
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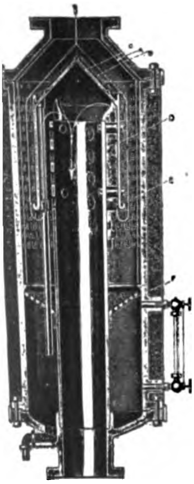
SWEETS SEPARATORS



FOR STEAM.

Remove all except one-half of 1 per cent. of water.

FOR OIL.

Remove 99 per cent. of it.

We can prove this and give good reasons for it.

In addition they have size and finish.

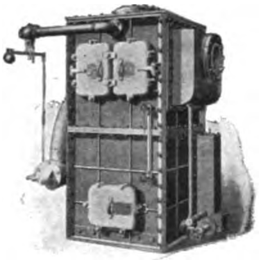
MADE IN ALL STYLES.

Direct Separator Co.,

218 GEDDES ST., · SYRACUSE, N. Y.

COCHRANE HEATERS

SAVE MONEY



COCHRANE HEATERS save *money* (incidentally they also save labor) by enabling you to utilize your exhaust steam to the best possible advantage—thus doing (with a waste product) work which would otherwise require *live steam* or *coal.* Given sufficient **exhaust** steam, they will increase the steaming capacity of boilers by feeding the boilers with HOT water—water at 200 or 210 degrees oftentimes saving the cost of installing new boilers, and the room and attention that new boilers would require. Cochrane Heaters also eliminate contraction and expansion strains on boilers, prolonging the life of the boilers and saving repair bills and the losses resulting from stoppages for repairs.

Cochrane Heaters save labor because of the simplicity of their design and construction, and because of the consequent ease with which they may be operated and cared for. A man can get inside of any Cochrane Heater that is large enough to hold him, and most of the work of cleaning the Heater can be done with a hoe and a hose. The Heater can be cleaned and put back into service in from half an hour to an hour and a half. Compare this with heaters having separate interior compartments, coils or curved tubes, and other inaccessible parts.

The list of savings is longer, but we haven't space here. Our **Catalogue 6 — H** fully illustrates and describes the Cochrane Heaters, and tells more of the economy and increased efficiency which they make possible. Send for a copy.

Harrison Safety Boiler Works,

3138 North 17th Street,
PHILADELPHIA, PA.

Manufacturers of Cochrane Feed Water Heaters, Cochrane Steam and Oil Separators and of the Sorge-Cochrane Systems.

EAGLE OIL AND SUPPLY COMPANY.
104 BROAD ST., BOSTON, MASS.

EAGLEINE
HOLD FAST
BELT DRESSING
makes
BELTS HOLD
16 2/3% BETTER
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EASE YOUR
MACHINES

and get more power and better service from them by using the

Wear Well Leather Packings
for hydraulic or compressed air.
Manufactured Exclusively by
Detroit Leather Specialty Co.
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Plastic Metallic Packing

One style, one size, no rings, no springs, for all pressures. Will not wear or cut rod. Increases efficiency of engine. Reduces friction to a minimum. Retains its plasticity. Never hardens. Always keeps the rod lubricated. Resists extreme temperature. Excellent for steam hammers and Corliss valve stems. Will send a test order on approval to any responsible firm. *Reliable Agents wanted.*

The HILEMAN-JAMES CO.
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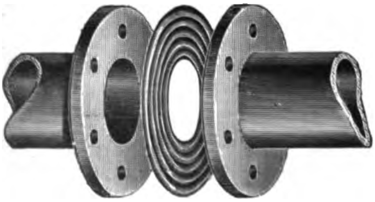
Our Patented Mineral Wool PIPE COVERING and



Copper Gaskets

THEY SAVE STEAM AND MAKE ABSOLUTELY TIGHT JOINTS.

Best and Cheapest Samples Free

UNITED STATES MINERAL WOOL CO.
143 Liberty St., NEW YORK

A GOOD BELT
IS A LABOR SAVER

Because it will not require frequent taking up and will do its work well.

Our IMPERIAL is that kind of a rubber belt. Made of special extra heavy duck and high grade rubber. The stitches help the rubber in holding the plies together.

IMPERIAL BELTING
MANUFACTURED BY
BOSTON BELTING CO.
ORIGINAL MANUFACTURERS OF MECHANICAL RUBBER GOODS.
ESTABLISHED 1828.

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for

Water, Steam, Air Gas, Suction, Fire Protection, etc.

Superior in quality. Satisfactory in service.

Packings, Gaskets, Valves and....
Mechanical Rubber Goods OF EVERY DESCRIPTION.

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Foster Class "W" Pressure Regulator

maintains a constant high delivery pressure regardless of variation in supply pipes. It can be adjusted according to the pressure to be maintained, and is built without weights, levers, or pistons. It is the standard reducing valve of the United States Navy.

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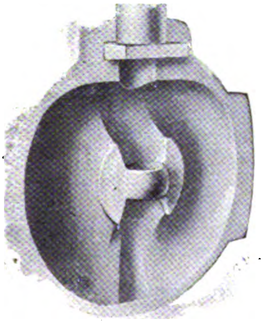
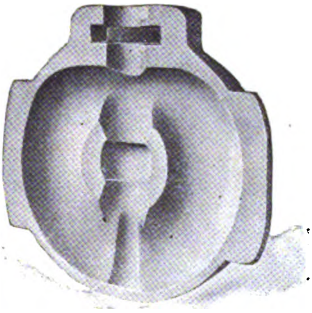


Showing back of disc with stem nut and center piece in place.



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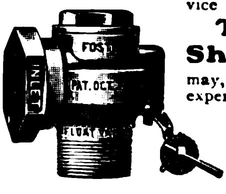

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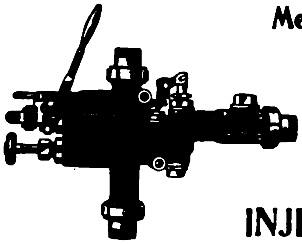

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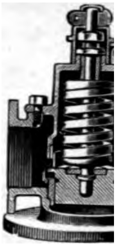

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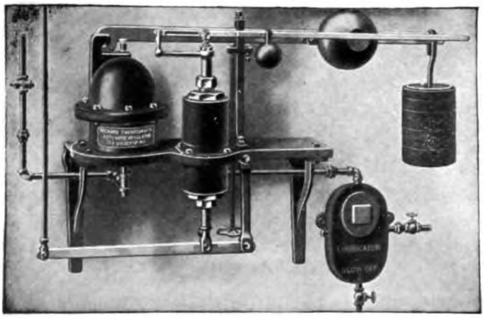

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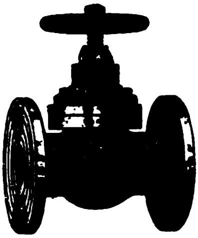
Fig. 253.



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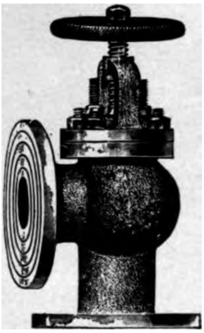

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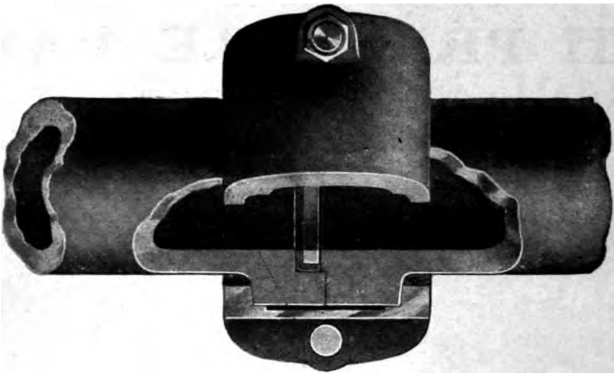

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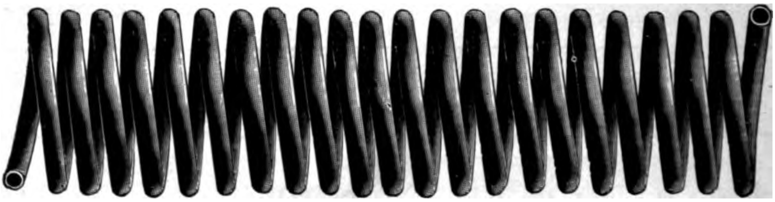

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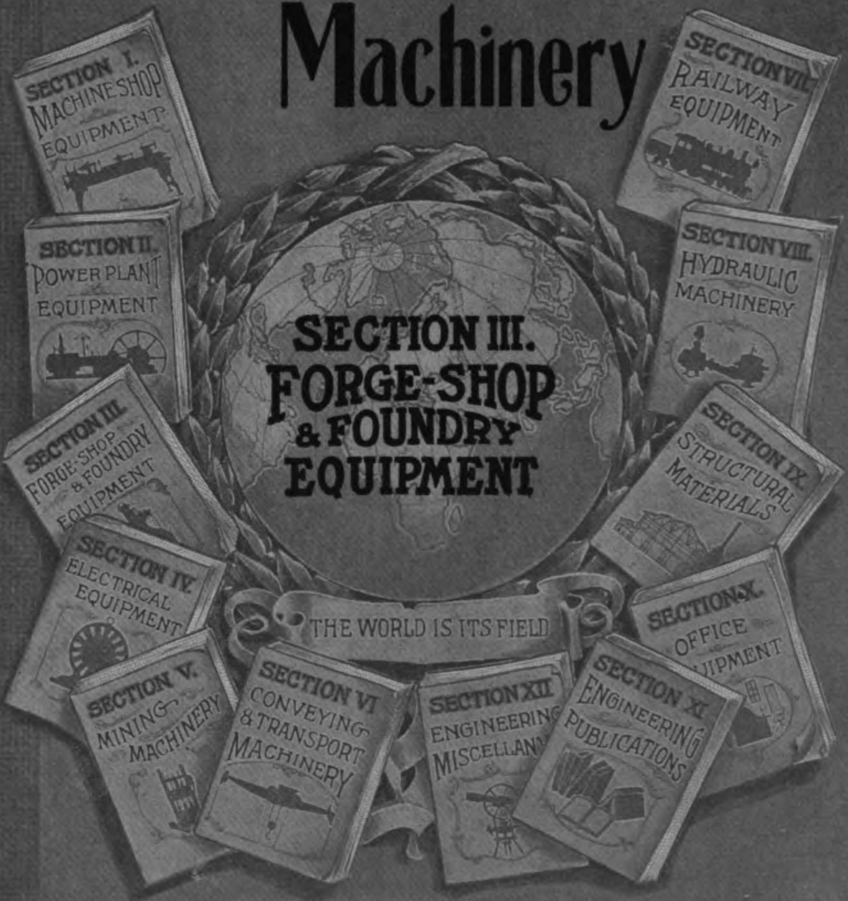

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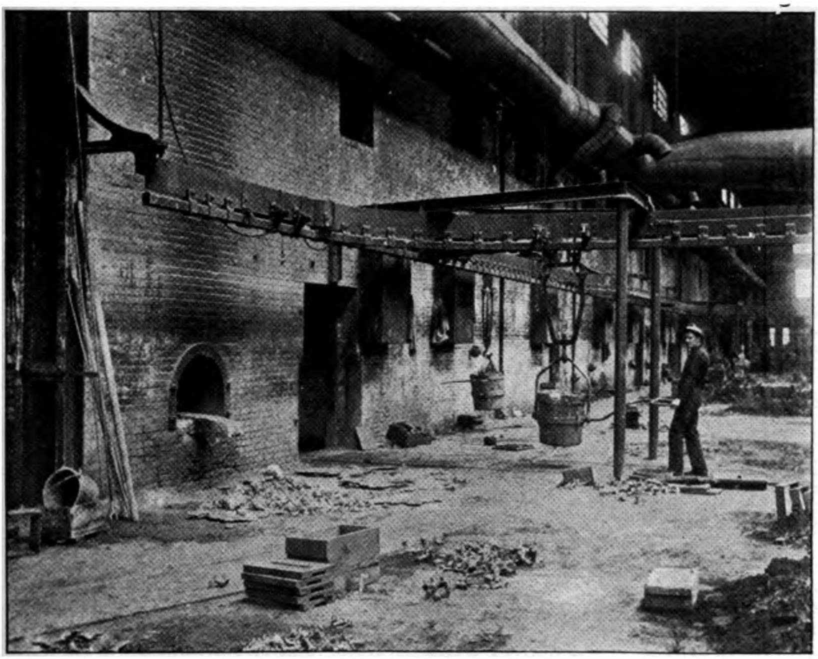

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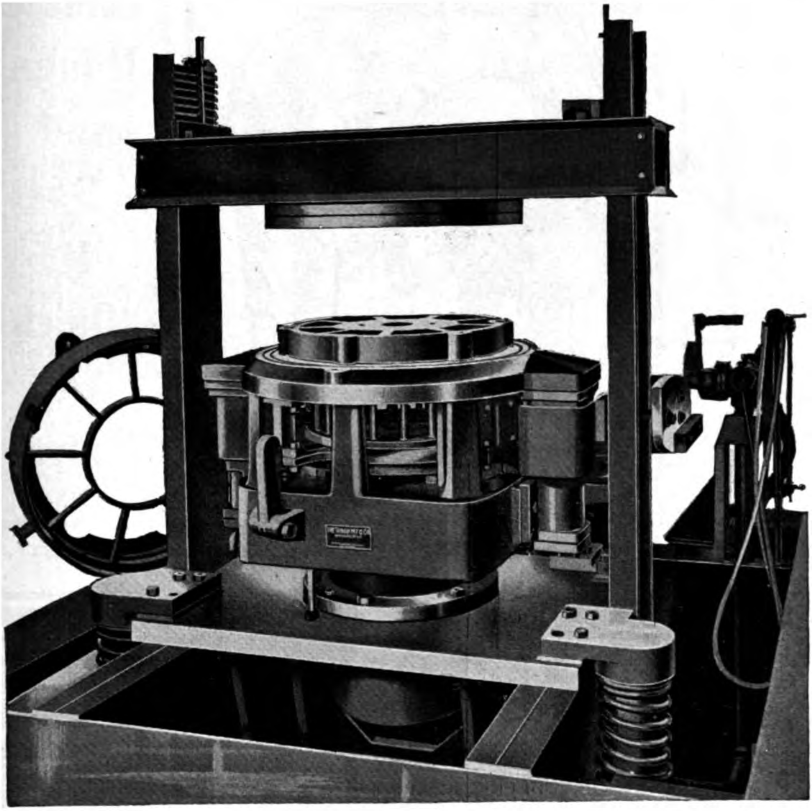

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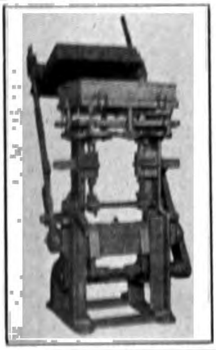

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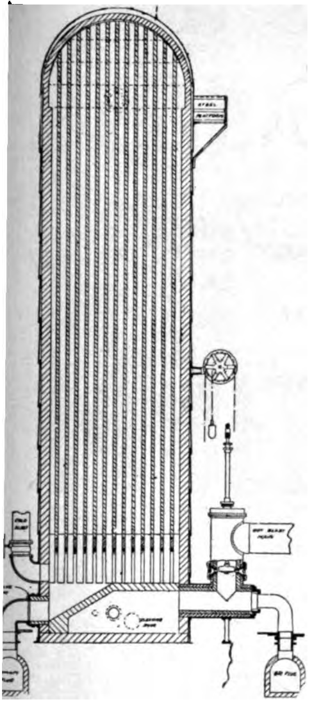

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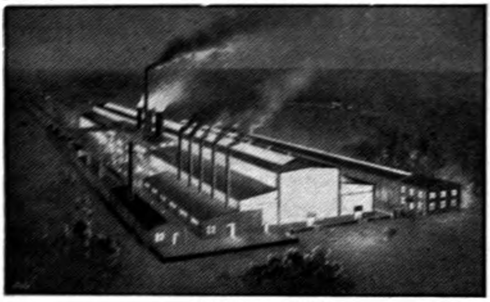

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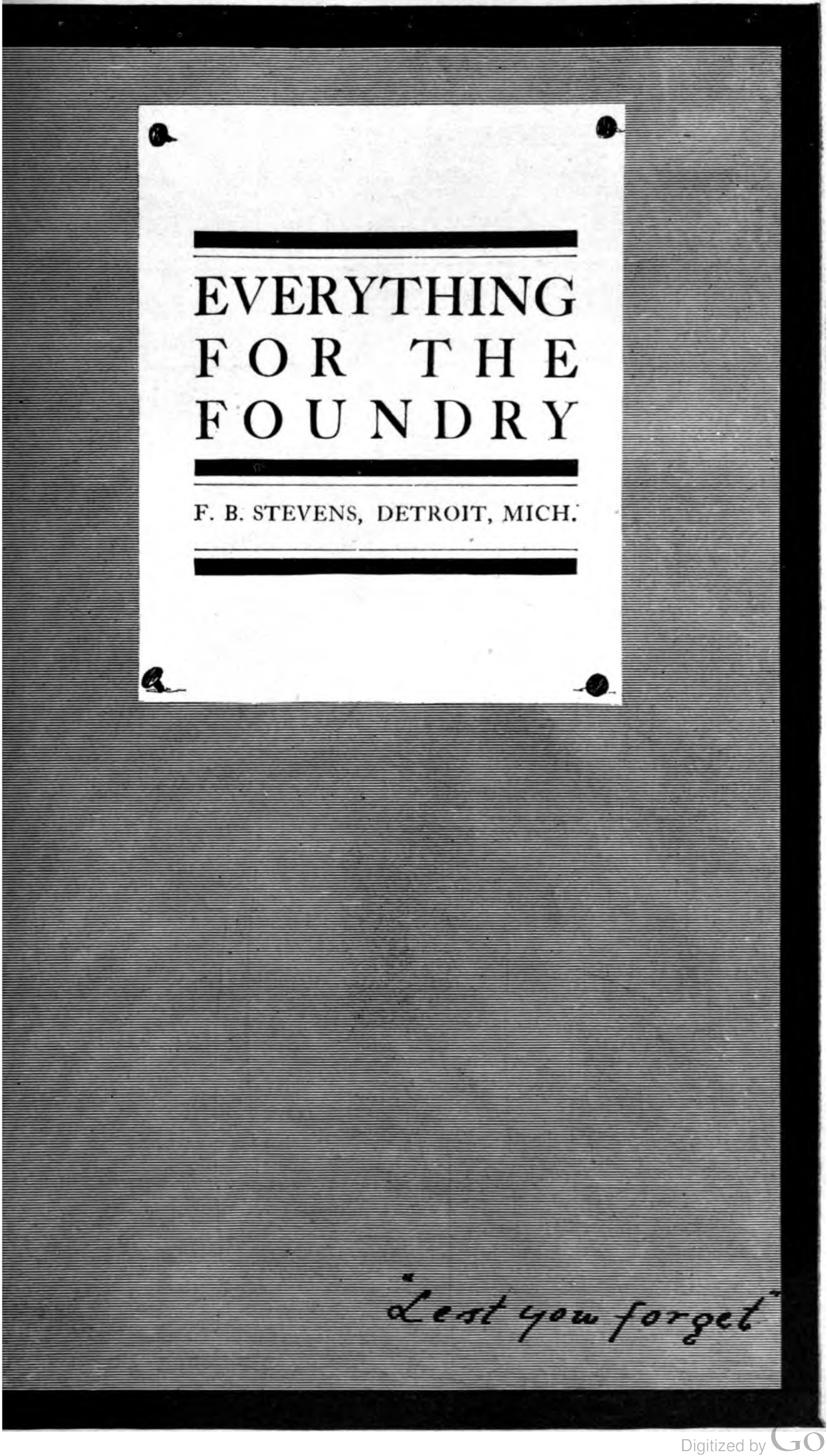

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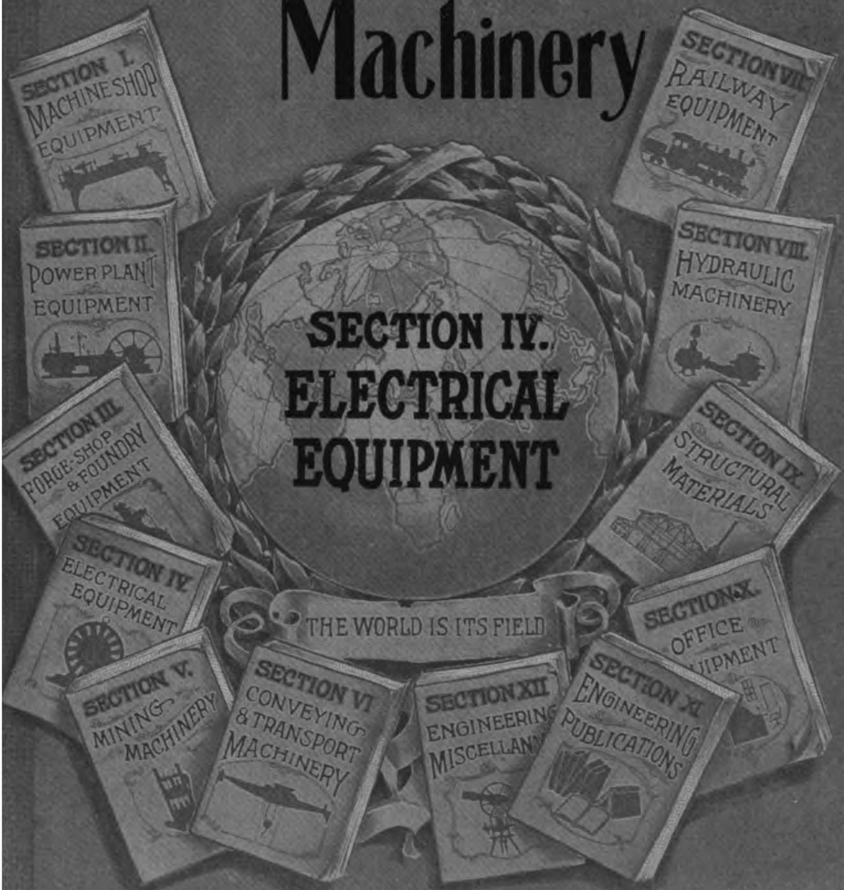
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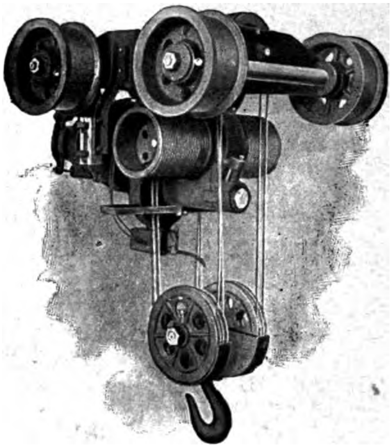

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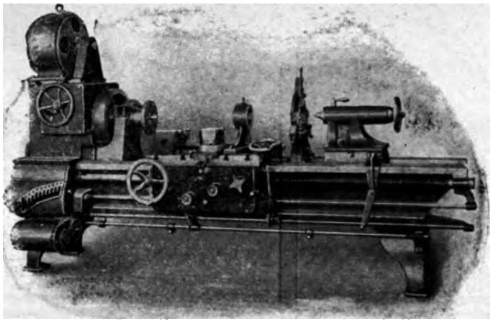

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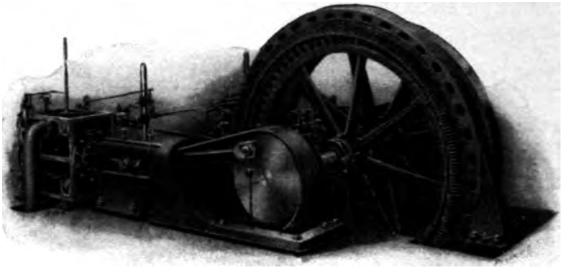

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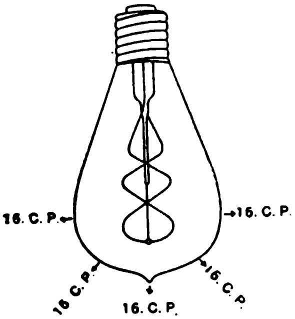

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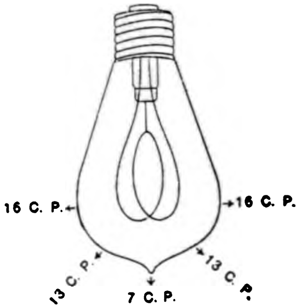

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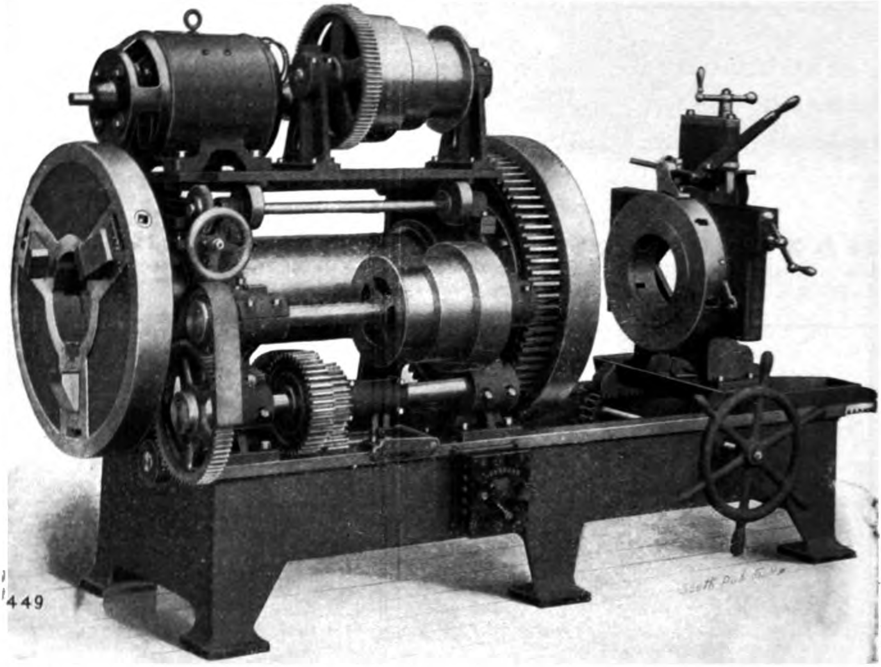

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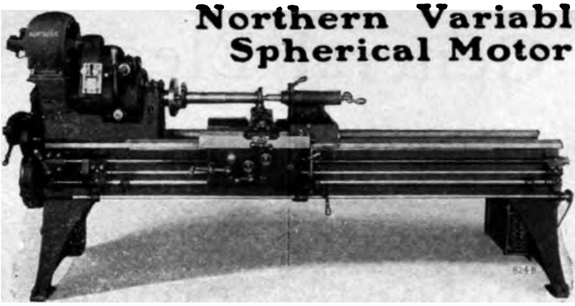

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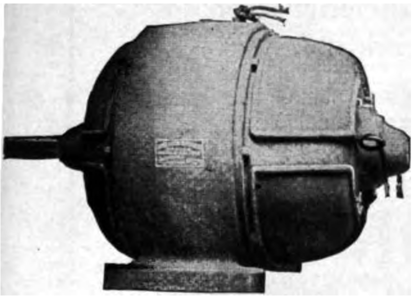

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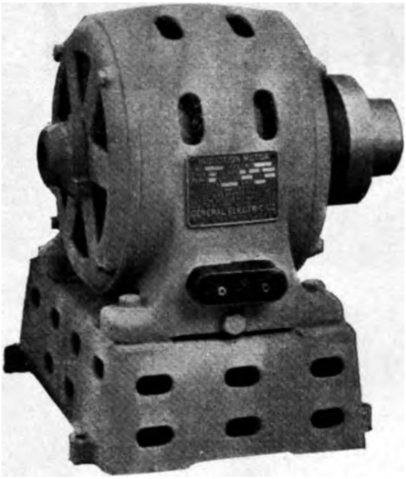

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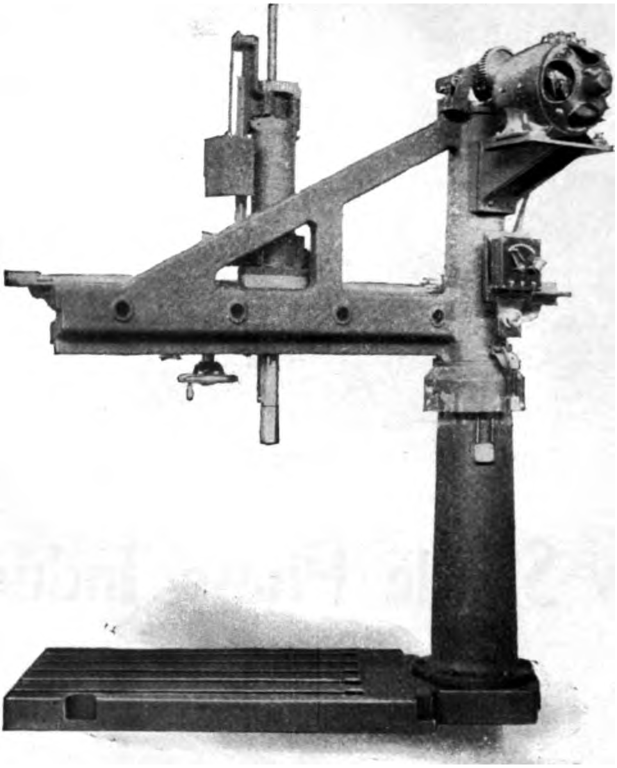

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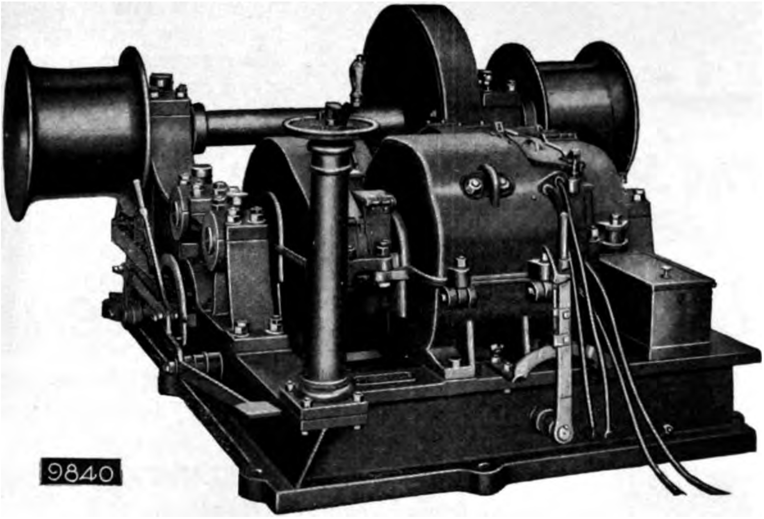

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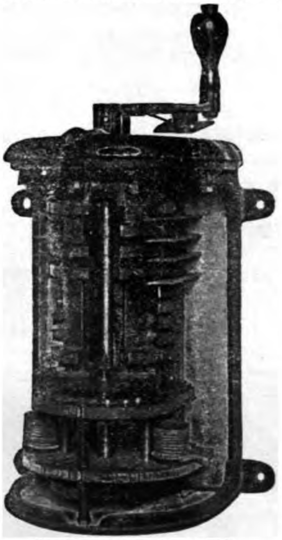

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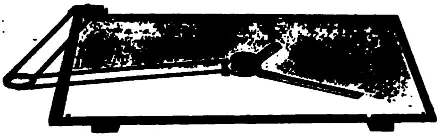

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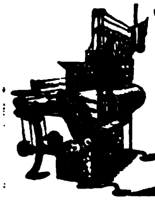

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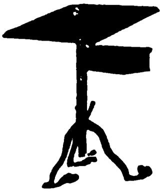

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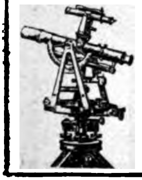

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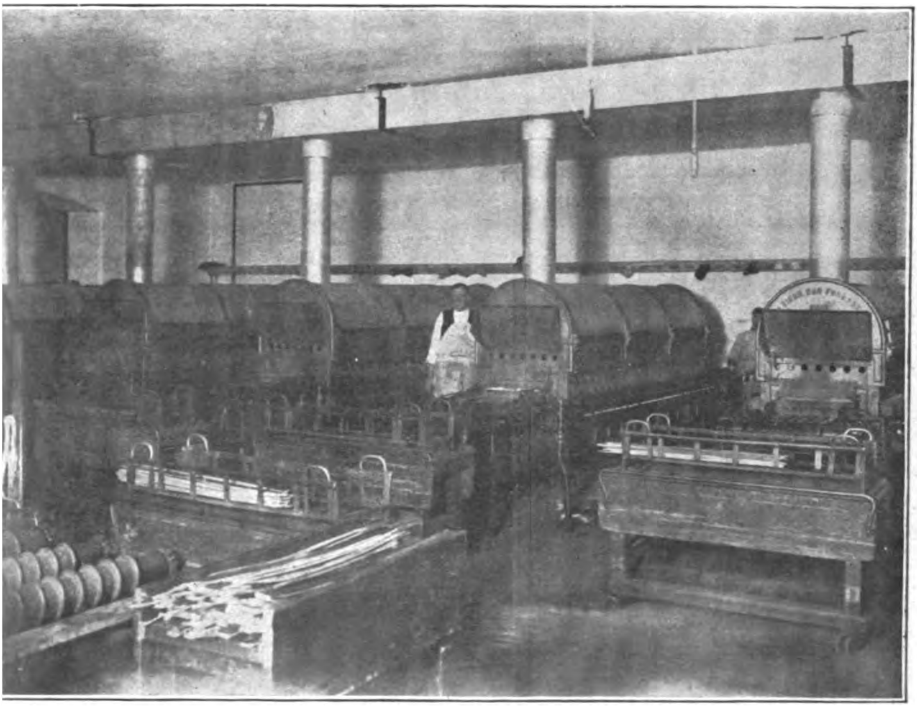

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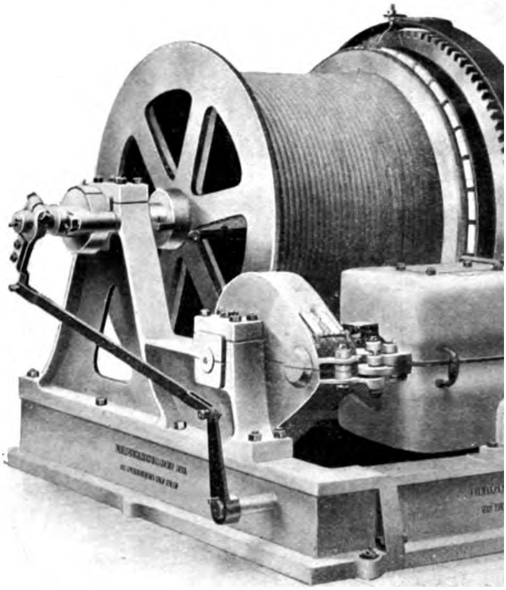

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INDEX TO ADVERTISEMENTS

A

ne Machinery Co........ 40
ims Co. 36
ree Iron Wks., Chester B. 42
erger Condenser Co.... 78
en Foundry Co. E. R.... 100
is-Chalmers Co. 62
eneder & Sons, Theo.... 193
a. Air Compressor Works 122
nerican Blower Co....... 85
nerican Bridge Co........ 12
herican Cement Co...... 163
nerican Conduit Co...... 106
n. Diamond Rock Drill Co. 123
m. Draft Furniture Co... 193
m. Electric Improvement Co. 77
merican Engine Co....... 66
merican Gas Furnace Co. 6-195
m. Hoist & Derrick Co... 137
m. Locomotive Co........ 145
merican School of Correspondence 182
merican Spiral Pipe Works 156
m. Steam Gauge & Valve Mfg. Co. 30
m. Tool & Machine Co... 205
merican Well Works..... 155
shley & Stern............. 198
shton Valve Co.......... 9
tlantic, Gulf & Pacific Co. 27
tlantic Works 73
tlas Engine Works....... 70
tlas Portland Cement Co.. 9
tlas Railway Supply Co... 144
udel & Co, Theo......... 57
ultman Co. 136
Austin Separator Co....... 82

B

Babcock & Wilcox Co...... 73
Baird & Co., Henry Carey.. 149
Baker-Vawter Co. 168
Baldwin Locomotive Works 144
Ball Bearing Co........... 54
Ball Engine Co............ 70
Ball & Wood Co........... 67
Bancroft & Co............ 100
Barnes Co., W. F. & John.. 44
Barnet Co., G. & H........ 2
Bartlett & Co., A. F....... 70
Baush Machine Co......... 35
Becker-Brainard Mill. Mch. Co. 36
Benedict & Burnham Mfg. Co. 4
Berlin Construction Co.... 158
Bethlehem Foundry & Machine Co. 55
Bickford Drill & Tool Co... 44
"Big Four" Route.......... 146
Bignall & Keeler Mfg. Co.. 38
Bilgram, Hugo 47
Blake Mfg. Co. Geo. F..... 153
Blanchard Machine Co..... 122
Borden & Selleck Co...... 132
Boston Belting Co......... 87
Boston Gear Works....... 47
Bourse, Philadelphia 6
Bradley Mfg. Co.......... 64
Brandis Sons Co.......... 193
Braun Co., F. W.......... 124
Brewer, W. M............. 198
Brill, Geo. M.............. 197
Bristol Company 206
Broderick & Bascom Rope Co. 129
Brooklyn Polytechnic Institute 200
Brooks & Co., T. H....... 165
Brown-Corliss Engine Co.. 68
Browning Engineering Co.. 134
Brown Hoisting Machinery Co. 134
Brown & Sharpe Mfg. Co.. 26
Bucyrus Co. 4
Buffalo Foundry Co....... 100
Buff & Buff Mfg. Co....... 193
Buhl Malleable Co......... 9
Bullard Machine Tool Co.. 37
Bullock Elec. Mfg. Co...... 108

C

C & C Electric Co......... 106
Cabot, Samuel 159
Cahall Sales Dept.......... 72
Calculagraph Co. 168
Caldwell & Son Co., H. W. 47
Caldwell & Co., W. E...... 165
Cameron Steam Pump Wks., A. S. 152
Carborundum Co. 46
Card & Weber Mch. Co.... 123
Case Mfg. Co............ 134
Catlett, Chas. 198
Chicago & Alton R'way Co. 149
Chicago, Mil. & St. Paul Ry. 148
Clarkson School of Technology 200
Clayton Air Compress. Wks. 122
Cleveland Punch & Shear Works 43
Cobb, Edward S........... 198
Coburn Trolley Mfg. Co... 95
Coes Wrench Co......... 55
"Compressed Air" 90
Consolidated Safety Valve Co. 90
Continental Iron Wks...... 205
Continuous Rail-Joint Co. of America 142
Contractor's Plant Mfg. Co. 134
Contractors Supply & Equipment Co. 160
Cost System & Auditing Co. 11
Cox & Sons Co............ 41
Crane Co. 66-91
Crocker-Wheeler Co. 105
Crosby Steam Gauge & Valve Co. 3
Cumberland Steel Co...... 46
Curtis & Curtis Co........ 43
Curtis & Curtis Mfg. Co.... 49
Cutler-Hammer Mfg. Co... 115
Cutter Co. 30

D

Dallett & Co., Thos. H..... 28
Darling, L. B............. 198
Dart Mfg. Co., E. M...... 84
Davis Co., John.......... 82
Davis Regulator Co....... 81
Dayton Globe Iron Wks. Co. 3
Deane Steam Pump Co.... 156
D., L. & W. R. R.......... 194
Denver & Rio Grande Ry... 148
Derry-Collard Co. 179
D'Este Co., Julian......... 80
De Nyse & Sons, Wm...... 196
Detroit Graphite Mfg. Co... 30
Detroit Leather Specialty Co. 86
Diamond Drill & Mach. Co. 41
Diemer, Hugo 198
Dieterich, C. A............ 198
Ditzgen Co., Eugene....... 193
Dingee, M. H. 99
Direct Separator Co....... 85
Dixon Crucible Co., Joseph 9-96
Doble, Robert McF........ 198
Dodge & Day............. 199
Drake & Co., F. J......... 180
Drouvé Co., G............ 159
Dunning, W. D........... 163
Durant Co., The W. N..... 168

E

Eagle Oil & Supply Co..... 86
Edison Portland Cement Co. 162
Electric Vehicle Co........ 196
Engineering Agency 199
Engineering Co. of Am.... 30
Epping-Carpenter Co. 152
Ericsson Telephone Co..... 6
Erie R. R................. 148
Eureka Fire Hose Co...... 205
Evans-Wilkins Co. 193

F

Fairbanks, Morse & Co..... 30
Fay & Egan, J. A......... 52
Fay & Scott............... 45
Federal Manufacturing Co. 54
Flagg & Co., Stanley G.... 206
Flint & Walling Mfg. Co... 165
Foster Mfg. Co., F. W..... 89
Foster Engineering Co..... 88
Frank Machinery Co....... 58
Frick Co. 74

G

Garrison Foundry Co., A... 100
Garry Iron & Steel Co..... 134
General Electric Co.....110-113
General Pneumatic Tool Co. 42
General Power Co.......... 2
Globe Mch. & Stamping Co., 41-98
Globe-Wernicke Co. 169
Goepel & Niles............ 197
Goubert Mfg. Co.......... 82
Gradstone & Co., M....... 27
Green Fuel Economizer Co. 76
Griffing Iron Co., A. A.... 80
Guarantee Electric Co..... 116
Guild & Garrison.......... 32
Gunn-Richards Co. 10-197

H

Hall Steam Pump Co...... 122
Hammel, C. A............. 145
Harron, Rickard & McCone 125
Harrisburg Foundry & Mch. Works 69
Harrison Safety Boiler Wks. 85
Hartford Steam Boiler Inspection & Ins. Co....... 116
Harvard University 200
Hayden & Derby Mfg. Co.. 90
Hayward Co. 205
Heine Safety Boiler Co.... 72
Hendrie & Bolthoff Mfg. & Supply Co. 125
Henshaw, Bulkley & Co.... 123
Hercules Gas Engine Works 154
Herron & Bury Mfg. Co... 122
Hess Machine Co.......... 36
Hileman-James Co. 86
Hilles & Jones Co......... 43
Hisey-Wolf Machine Co... 51
Hohmann & Maurer Mfg. Co. 3
Holt & Schober........... 198
Hooven, Owens, Rentschler Co. 66
Hoppes Mfg. Co.......... 84
Howard Iron Works....... 34
Hudson Engineering & Contracting Co. 199
Hunt Co., C. W........... 138
Hunt & Co., Robt. W...... 15[illegible]

I

Illinois Central R. R....... 148
Imhauser & Co., E......... 3
Industrial Works 137
Ingersoll-Sergeant Drill Co. 119
Irwin Machinery & Supply Co., E. W............. 49

J

Jantz & Leist Electric Co... 109
Jefferson Mfg. Co......... 144
Jeffrey Mfg. Co.......... 135
Jenkins Bros. 206
Jessop & Sons, Wm., Ltd... 51
Jones & Lamson Mch. Co... 44
Jour. Assn. Eng. Societies.. 28

K

Kansas University 201
Kelley Island Lime & Transport Co. 163
Kennedy, Julian 199
Kennedy, Walter 197
Kennedy Valve Mfg. Co... 89
Keuffel & Esser Co........ 19[illegible]
Keystone Drop Forge Wks. [illegible]
Kilbourne & Jacobs Mfg. Co. 1

INDEX TO ADVERTI

Kingsford Fdy. & Mch. Wks. 154
Kinnear Mfg. Co. 30
Kloman Co., Inc. 99
Knowles Steam Pump Wks. 154
Koppel, Arthur 133
Koven & Bro., L. O. 78

L

Lacy Mfg. Co. 156
Lafayette College 201
Laidlaw-Dunn-Gordon Co. 154
Lake Shore R. R. 147
Lambert Hoisting Engine Co. 137
Landis Tool Co. 40
Latrobe Steel Co. 100
Lawrence Cement Co. 206
Lawrence Scientific School 200
Lehigh University 200
Leschen & Sons Rope Co., A. 133
Lewis Institute 200
Lidgerwood Mfg. Co. 32-202
Lima Locomotive & Machine Co. 144
Link-Belt Engineering Co. 131
Lombard Governor Co. 153
Lubrication Publishing Co. 36
Lunkenheimer Co. 89
Lyon & Co., J. D. 90
Lyon Metallic Mfg. Co. 41

M

Mabbs Hydraulic Packing Co. 91
McCabe & Co., P. B. 125
McClure, Son & Co., G. W. 197
McGill University 201
McGowan Co., John H. 155
McNab & Harlin Mfg. Co. 91
Machinery & Electrical Co. 125
Manning, Maxwell & Moore 90
Marion Steam Shovel Co. 3
Maryland Steel Co. 8
Mass. Inst. of Technology 200
Maurer & Son, Henry 11
Mead Mfg. Co., John A. 135
Merritt & Co. 53
Michigan College of Mines 200
Michigan Pipe Co. 156
Mietz, A. 69
Miller & Franklin Co. 198
Minneapolis Steel & Mchy. Co. 74
Moore & Co., Chas. C. 81
Moran Bros. 90
Morgan Construction Co. 198
Morris, P. H. 3
Morris Machine Works 154
Morse Chain Co. 130
Morse Twist Drill & Machine Co. 9
Morse Elevator Works 54

N

National Acme Mfg. Co. 39
National Electric Co. 106
National Fireproofing Co. 164
National Machinery Co. 40
National Pipe Bending Co. 81
New Process Rawhide Co. 47
New York Central R. R. 149
New York Continental Jewell Filtration Co. 6
Niagara Mch. Tool Wks. 4
Nicholson File Co. 2
Niles-Bement-Pond Co. 29
North Electric Co. 114
Northern Elec. Mfg. Co. 109
Norwalk Iron Works Co. 122
Norwich University 201
Nuttall Co., R. D. 47

O

Obermayer Co., S. 94
Oglesby, Milton L. 198
Orford Copper Co. 12

P

Palmer, W. K.
Paraffine Paint Co.
Parson Mfg. Co.
Patent Record
Patterson Tool & Supply Co.
Pelton Water Wheel Co.
Penna. Military College
Penna. Silica Brick & Mfg. Co.
Penna. State College
Pennsylvania Steel Co.
Pennsylvania University
Phila. Pneumatic Tool Co.
Phillips Mine & Mill Supply Co.
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Porter & Co., H. K.
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Power and Mining Machinery Co.
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Power Specialty Co.
Power & Speed Controller Co.
Pratt Institute
Pratt & Whitney Mfg. Co.
Providence Eng'ng Works

Q

Quimby, Inc., Wm. E.
Quincy Engine Works

R

Rand Drill Co. 120-
Ransom Concrete Mchy. Co.
Reeves Engine Co.
Reeves & Son, Paul S.
Rensselaer Polytechnic Inst.
Riter-Conley Mfg. Co.
Robins Conveying Belt Co.
Robbins & Myers
Robinson, A. W.
Roebling Construction Co.
Roelker, H. B.
Roessler & Hasslacher Chemical Co.
Rogers Locomotive Works
Rose Polytechnic Institute
Ross & Co.
Ross Valve Co.
Rotary Engine Co.

S

Sage, Chas. S.
St. John Grate Bar Co.
Scaife & Sons Co., Wm. B.
Schieren & Co., Chas. A.
Scranton & Co.
Sellers & Co., Wm.
Shaw, E. M.
Sheffield Scientific School
Shepherd Engineering Co.
Silicate Stone Co.
Simmons Co., John
Simplex Electric Heating Co.
Skinner Engine Co.
Smidth & Co., F. L.
Smith Co., H. B.
Snow Steam Pump Works
Southern Pacific Co.
Southwark Fdy. & Mch. Co.
Sprague Electric Co.
Standard Diamond Drill Co.
Standard Gauge Mfg. Co.
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Star Brass Mfg. Co.
Steptoe Shaper Co., John
Sterling Electrical Mfg. Co.
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